THE

ELECTRICAL REVIEW.

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THE

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1901 Edition

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FUEL ECONOMY.

EVERY now and then the surface of the nation's mind is perturbed by the figures of some prophet who strives to prove, what should not need proof, that we cannot eat our cake and have it too. There is only a limited quantity of coal in the earth, so there can be only a limited supply (unless in later days we run ætherial trains to rob the Martians).

Whether the end of that supply will come in a hundred years, or in several hundred years, is the question to which the answer must be given by this and the next few generations. Hitherto we have been drawing prodigally, without much thought, on the coal deposits, and every year our draught increases enormously.

If we took the utmost value from the coal we consume we should not be open to reproach, but it is too evident that we do not.

It is true that great strides in the direction of economy have been made of late years, and that most men have a notion that to save coal is to save their pockets; but it is true also that for one works of any description in which power or heat are generated economically, there are a hundred or more in which waste of fuel is rampant.

We have only to look around to see inefficient and badly-fired boilers, non-condensing engines, miles of shafting, waste gases from blast furnaces and the domestic chimney, to assure ourselves of this ever-present and ever-increasing waste.

We think only of to-day and of ourselves, and nothing of to-morrow and the people of to-morrow. We put money in our pockets and care not that the race may die out the sooner for our prodigality. We continue to draw out the capital of the world without acknowledging the fact that it is capital, that it cannot be replaced, and that no over-draught is permitted by the Bank of Nature.

At a period more or less remote a starving army corps will be guarding the last lump of coal in the world at the British Museum, while the inhabitants of Great Britain, with the exception of a few millionaires (who get their heat fresh from America's waterfalls daily), cower for warmth in the bowels of the earth where the coal used to be.

Speaking seriously, when we waste fuel we do an immoral act; an act which merits punishment as much as the act of a man who robs a child of its patrimony. It is an old saying that a man has not lived in vain when he has made two blades of grass to grow where one was before. So that man who obtains equal results with ½ lb. of coal where 1 lb. was used before, has lived to some considerable purpose; and the men who show how such economies are to be obtained are worthy of great praise, and the thanks of the generations to come—the generations to whom the problems of the coal supply will assume far more terrifying aspects than our annual crises in the Far East, or the prospect of general war.

We look forward to the time when it will be an indictable

offence to waste fuel; when a man will get six months' hard labour for not lagging his steam pipes, for not using economisers, or for running non-condensing—perhaps for using steam plant at all.

Electrical engineers have seemed always to have aimed at the best economy in their works; if not for the sheer personal pleasure of getting good results, as we fully believe, then because of the publicity of their achievements afforded by the statements according to the Board of Trade.

It came, therefore, as a shock to find from the lists of the supply companies, lately presented with the ELECTRICAL REVIEW, that so many stations lacked condensing plant.

The reasons for this may be various and good. The chief is probably the lack of a suitable water supply; but nowadays, with such a host of good and indifferent water coolers and similar contrivances on the market, that reason is not retort-proof, nor the usually accompanying cry of "no-room."

The following figures are summarised from the REVIEW lists:—

DIRECT CURRENT STATIONS.

Provinces—	Kilowatts.	No. of stations.
Total capacity of works in kilowatts	99,500	117
Total non-condensing kilowatts ...	22,370 (22 %)	47½
Total part-condensing kilowatts ...	21,560 (21 %)	6
Not specified as either	282	4
Water-power stations	153	2
Gas-power stations	859	7
Motor-driven stations	1,454	3
London—		
Total capacity in kilowatts	33,500	16
Non-condensing	26,000	11½
	(20 % of U.K., 78 % of London.)	

ALTERNATING STATIONS.

Provinces—		
Total capacity of works in kilowatts	67,180	71*
Wholly non-condensing	4,469 (6 %)	9
Partly non-condensing	2,840 (3 %)	3
Not specified	360	2
Water-power stations	334	3
Gas-power stations	166	2
London—		
Total capacity of works	21,056	9†
Wholly non-condensing	11,906	4
	(13 % of U.K., 57 % of London.)	

DIRECT AND ALTERNATING STATIONS.

London and Provinces—		
Total capacity of works	221,236	213
Wholly non-condensing	(64,750 (29 %)	68

* One station not having returned capacity of works.
† City of London Company, M. E. S. Company, and London Electric Supply Company not having returned capacity of works.

What strikes us first is the lead which the provincial alternating stations have given to the direct current stations in the matter of condensing. Only 6 per cent. of their plant is run to atmosphere, while the continuous people show 22 per cent. Is this because the direct current stations had to be built in the centre of the area of supply, while the higher pressure alternating stations were located with more regard to natural facilities? Whatever the reasons, the facts are here. In London, too, without the aid of three of the largest stations (all condensing), alternating current leads in condensing by 21 per cent.

In the United Kingdom there are stations aggregating 64,750 KW. which do not condense. Let us call one quarter of this spare plant, leaving 48,562 KW. for continuously running plant. In one year, at 100 per cent. load factor, this plant will generate 425,500,000 units; but if we take a load factor of 12 per cent. as an average for the whole of the lighting stations (it is difficult to get this figure) the plant will turn out 51,048,000 units per annum.

Who shall say that 10 lbs. of coal per unit is much too large a figure for the average non-condensing plant? If the figure is allowed, and if it is admitted that 25 per cent. of this fuel would be saved by condensing with a good vacuum, a little arithmetic will prove that 57,000 tons of coal might be saved per annum in lighting stations alone; and that coal used as our experience ought to have taught us how to use it, would give us 20 to 30 million units per annum—a considerable fraction of the annual output of the Kingdom's plant.

Of course, this is to put the worst face on the matter. It is to be hoped that all the exhaust steam does not rush from the engines into the atmosphere without being worried a little by feed heaters, injectors, and other things. There can be no doubt that much in that way is done.

Economisers seem to be in the flues of most stations, but the possibilities of superheating have not occurred to everyone.

No engineer should be happy, or sleep well, till he is assured that every pound of coal he burns, and every pound of steam he produces have all the "goodness" taken out of them, and applied in a useful form at the terminals of his machines. He will find that reciprocating engines are not so economical as steam turbines, so he will scrap his engines, and when he finds that turbines are gluttons compared with gas engines, they will follow the steam engines.

This worthy engineer, it must be explained, cannot be hampered with directors or committee-men, and must care nothing for balance-sheets.

Not only should every electrical engineer strive to reduce the fuel consumption in his own station; he should endeavour on all occasions to instil ideas of economy into the minds of the owners or managers of all works and factories over which he may go, and he should be primed with tales of shekels saved, to drive his good words home.

The Musical Arc.

PEUKERT has recently shown that in the musical arc discovered by Simon we have an exceedingly convenient means of producing alternating currents of very high frequency and moderate tension. He made use of Duddell's arrangement of the circuits, with a choking coil in the main circuit to prevent the alternate currents leaking out of the shunt circuit in which they are produced. With the arc used in Peukert's experiments the pressure of the alternating currents was 42 volts, and the frequency 8,000 to 9,000. With the oscillating currents thus produced, all the well-known experiments of E. Thomson were successfully repeated. Rings of aluminium and copper were caused to float above the end of an electro-magnet energised by the currents; glow lamps short-circuited by a bent wire were readily incandesced; and the surface concentration of alternating currents was demonstrated. As an example of the last mentioned effect, an iron wire 12 mm. diameter had its apparent resistance increased 29-fold. Peukert has discovered that no telephonic or other vibrator is necessary to start the oscillations in the shunt circuit of the arc. All that is necessary is to close the circuit, whereupon the electric oscillations start automatically, and continue while the arc is of suitable length. When, however, the length of the arc is increased beyond a certain limit, the oscillations cease, but are re-established when the length is again brought within the working limit.—*Elektrotechnische Zeitschrift* 22, p. 467.

MARCONI'S SYSTEM OF SYNTONISED WIRELESS TELEGRAPHY.

Since the publication of Dr. Fleming's letter in the *Times* dated October 4th, 1900, a great deal of curiosity has been excited as to the nature of the methods by which Marconi obtained the remarkably successful results described in that letter. A complete explanation of his system has now been given by Mr. Marconi himself in a paper read before the Society of Arts on May 15th. Marconi's system may be stated generally to depend on the use of circuits with sufficiently large inductance and capacity to prevent oscillations being quickly damped out. A long train of waves is thus given out by the radiator or transmitter, and though a single wave is insufficient to excite oscillations in the receiver, the cumulative effect is sufficient if the natural period of oscillation of the receiver is the same as that of the transmitter. To take an analogy given by Dr. Fleming in the discussion, a cork floating on water would be bobbed up and down by any wave, long or short, that went over it, but a heavy log of wood floating on the water, and tethered to the bottom of the sea by a spiral spring, would only be caused to bob up and down by waves having one particular period.

With simple vertical wires, connected directly to the coherer and to the spark gap, as used by him before 1898, Marconi found that no really satisfactory tuning was possible. It was, however, possible to obtain a certain selection of signals if various stations in the vicinity used vertical wires differing very considerably in length. For example, two stations communicating over a distance of, say, five miles, and using aerial wires 100 ft. long, would not interfere with signals transmitted between other two stations in the neighbourhood with aerials 20 ft. in length.

Much better results were obtained with the method adopted in 1898, in which (see fig. 1) the receiving aerial

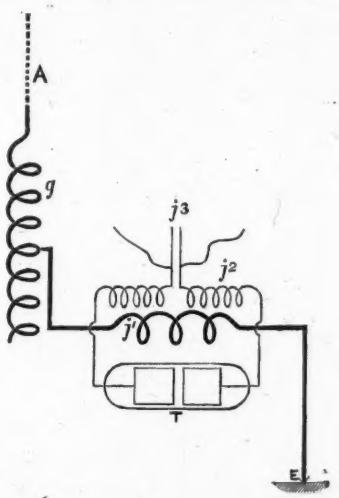


Fig. 1.

A was directly connected to earth E, instead of to the coherer, and in which the coherer T was placed in series with a condenser in the secondary circuit j^2, of an oscillation transformer tuned to respond best to waves given out by a given length of aerial wire. Marconi's first British patent describing this method was applied for June 1st, 1898, (No. 12,326). This system was used in maintaining communication with the East Goodwin Lightship during 1899, and for communicating across the Channel that same year at the meeting of the British Association at Dover. The Admiralty were also supplied, in the course of the year 1900, with 32 installations on this plan, all of which passed a 100-kilometre test for range.

In his further experiments with the view of arriving at syntonic telegraphy, Marconi soon found that the simple aerial wire was ill adapted for this purpose. A transmitter connected to a vertical conductor is not a very persistent oscillator. Its electrical capacity is comparatively so small, and its capability of radiating waves is so great, that the oscillations excited in it are quickly damped out. On this account receivers or resonators of considerably different period or pitch will respond to it. The reason is that nearly all the energy of the transmitter is given out in two or three strong oscillations, which singly are capable of affecting the receiver, while if the energy is spread out over a long train of waves, each too feeble to affect the receiver, then the resonant effect comes into play.

Marconi pointed out in a Patent Specification, dated December 19th, 1899, No. 25,185, that the best results are obtained when the length of the wire of the secondary of the induction coil is equal to the length of the vertical wire used at the transmitting station. Marconi considers that this is an anticipation of Slaby's discovery of the "extension wire," but it is difficult to see that there is much analogy between the two cases.

A large number of experiments were carried out by adding inductance coils to the radiating and receiving wires, on the principle suggested by Lodge in his patent, No. 29,069, of 1898, but without obtaining satisfactory results. The failure was attributed to the fact that the capacity of the exposed conductors was too small in proportion to the inductance. The first and obvious method of getting over the difficulty was to increase the capacity by increasing the surface of the conductors, but objections were found in the fact that increased surface meant increased radiating power, and large exposed areas were impracticable on board ship.

The way out of the difficulty was found by adopting the arrangement shown in fig. 2.

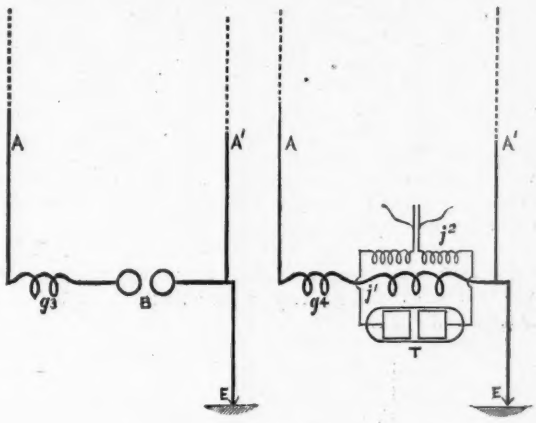


Fig. 2.

Here there is an ordinary vertical radiator, A, placed near an earthed conductor, A^1, the effect of the adjacent conductor being obviously to increase the capacity of the electrical radiating wire without increasing its radiative power. Syntonic results were not difficult to obtain with this arrangement. This arrangement was tried in 1899. Early in 1900 Marconi obtained very good results with the arrangement shown in fig. 3. This arrangement is fully described in a British patent, No. 5,387, applied for in March, 1900. In it the radiating and resonating conductors, A, take the form of a cylinder, the earthed conductor, A^1, being placed inside. This form of radiating and receiving apparatus is much more efficient than that illustrated in fig. 2. The one necessary condition of success with this system is that the inductance of the two conductors should be unequal, it being preferable that the large inductance, g^3, should be connected to the non-earthed conductor. Marconi's explanation of this peculiar effect is that a difference of phase in the two conductors is essential to ensure radiation, since otherwise their effects would neutralise each other. The results obtained by this system have been remarkable. By using cylinders of zinc only 7 metres high and 1·5 metres in diameter, good signals were easily obtained over a distance of 30 miles; and these signals were not interfered with by other wireless telegraph installations working in the immediate vicinity. The closely adjacent plates and the large capacity of the receiver cause it to be a resonator with a very decided period of its own, *i.e.*, it becomes no more liable to respond to frequencies which differ from its own particular period of

oscillation, nor to be affected by disturbance due to atmospheric electricity.

Another very successful syntonic system was founded on the known properties of Lodge's syntonic jars. In a well-known experiment, Lodge showed that when a spark passes between the inner and outer coatings of a Leyden jar, a spark is induced in a similar jar a few yards off, but anything which throws the second jar out of tune with the first prevents the effect. Oscillations induced in a Leyden jar circuit are very persistent, but the arrangement is a very bad radiator, and will therefore not influence a receiver except at a very moderate distance. Marconi aimed at increasing the radiating power of the condenser circuit, and this he found could be done by setting up an earthed aerial conductor close to the jar. It was soon discovered, however, that the best effects could only be obtained when the aerial conductor was syntonised with the Leyden jar circuit. The transmitter is shown in fig. 4.

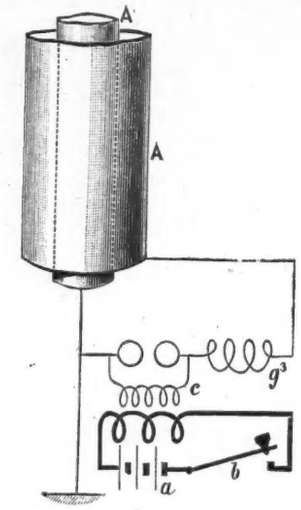


FIG. 3.

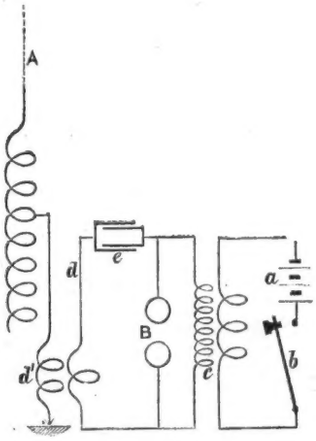


FIG. 4.

The period of oscillation of the vertical conductor, A, can be increased by introducing turns of the coil at the lower end, or decreased by diminishing the number, or by introducing a condenser in series with it. The condenser, *e*, in the primary circuit is constructed in such a manner as to render it possible to vary its electrical capacity. The spark at the gap, B, is produced by the induction coil, C, in the usual manner. The receiving station arrangements are shown in figs. 1 and 5. In fig. 1 the vertical conductor is connected to earth through the primary j^1 of a transformer, the secondary j^2 of which is connected to the coherer T. The battery connections are shown at j^3; *g* is the inductance coil for syntonising the aerial wire, A, with the coherer circuit. In fig. 5 a condenser, *h*, is introduced as a shunt to the coherer circuit to make tuning more marked. In order that tuning may be perfect, it is necessary that the product of the inductance and capacity in all the four circuits should be equal, *i.e.*, in the two circuits of the transmitter, and in the two circuits of the receiver. A complete and detailed description of this system is given in Marconi's British patent, No. 7,777, April, 1900. Prof. Braun has recently adopted the same principle in his system of wireless telegraphy, but Marconi considers that he has priority.

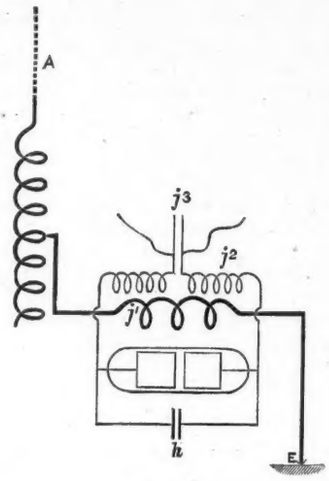


FIG. 5.

Experiments have confirmed the fact that the receiving induction coils having the secondary wound in one layer, and at a certain distance, say 2 mm. between turns (to make the capacity negligible), have a period approximately equal to that of a vertical conductor of equal length. If, therefore, an induction coil having a secondary 40 metres long, is used in the receiver, a vertical wire 40 metres long should be used both at the transmitting and receiving stations. All that is necessary then is to adjust the capacity of the condenser at the transmitter, till the signals are most effectively recorded at the receiver.

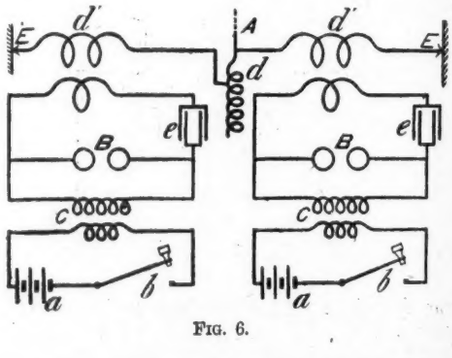


FIG. 6.

It is easy to understand, that if there are several receiving stations, each tuned to a different frequency, and of which the corresponding inductance and capacity at the transmitting station are known, it will not be difficult to transmit messages to any one of them, without danger of the message being picked up by the other stations for which it was not intended. But, more remarkable still, it is possible to connect to the same vertical sending wire through connections of different inductance several transmitters of different frequency, and to the single receiving wire a number of corresponding receivers. With this arrangement, shown in figs. 6 and 7, multiple wireless telegraphy is possible between the two stations, the messages being simultaneously sent off, and each received on its own recording instrument without interference from the other messages. The successful accomplishment of this feat was shown to Dr. Fleming

among others, and was recorded by him in his letter to the *Times* of October 4th, 1900. A further improvement has been since obtained by replacing the vertical wires by the

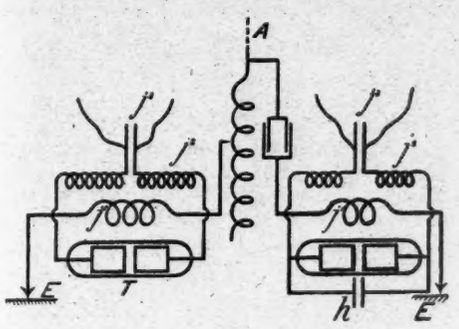


Fig. 7.

cylinders (fig. 8). With this arrangement signalling has been carried out over a distance of 50 kilometres (30 miles), with a cylinder only 1·25 metres high and 40 in. in diameter.

This latest advance has led to the possibility of constructing portable apparatus for army purposes, which, as the inventor says, should be of great service in the field. A complete installation has been mounted on a steam motor car, on the roof of which there is placed a cylinder which can be lowered when travelling, its height being only 6 or 7 metres. By this means communication has been easily

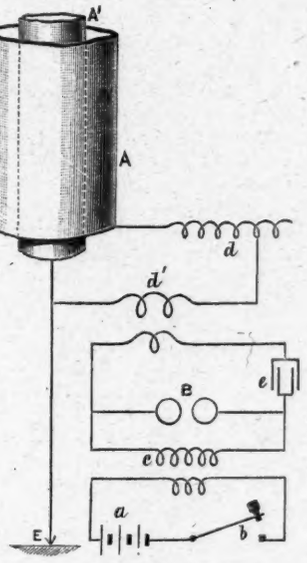


Fig. 8.

carried out with a syntonised station over a distance of 31 miles. A 25 cm. spark induction coil worked by accumulators and taking about 100 watts is used for transmitting. The accumulators can be recharged by a small dynamo driven by the car motor. No earth connection is necessary, it being sufficient to connect the ærial wire to the boiler of the motor car.

Last spring Marconi succeeded in telegraphing over a distance of 186 miles (from the Lizard to the Isle of Wight). The apparatus used was that shown in figs. 1 and 4, and the power employed not more than 150 watts. Experiments with larger powers will shortly be carried out. The aerial conductors consisted of four vertical wires, 1·5 metres apart and 48 metres long. Numerous experiments have confirmed a law formerly enunciated by Marconi that, *ceteris paribus*, the range of transmission varies as the square of the height of the vertical wires at the two stations.

Mr. Marconi criticised somewhat unfavourably the system of wireless telegraphy invented by Prof. Slaby. Slaby's transmitter (fig. 9) consists of a vertical wire A C with a spark gap A B and condenser K. The top of the wire A C is connected to earth through a choking coil C D and a second vertical wire D E. Marconi tried this transmitter over his 50-kilometre range between Poole and the Isle of Wight, and found that he got better results when the coil C D and wire D E were removed. Marconi considers that leakage of electric waves takes place through the coil C D, and thereby reduces the energy radiated. But according to Slaby, a necessary condition of success with his apparatus is that the coil C D should be out of tune with the wire A C, and it is not clear that this condition was fulfilled in Marconi's experiments. Marconi also considers that the "multiplicator" used by Slaby at the end of "extension wire" of his receiver is practically equivalent to the transformer used in

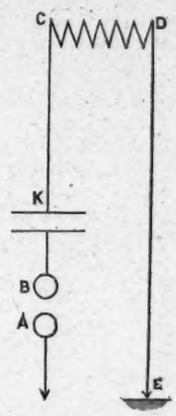


Fig. 9.

the Marconi apparatus. But in Slaby's coil there is no secondary wire as in the Marconi apparatus, and therefore there is no multiplication of tension due to the greater number of turns on the secondary. There is, of course, in both arrangements the syntonised inertia of the coils, but this appears to be obtained by different means, and we do not see that Marconi makes out that Slaby has, in this respect, appropriated his invention. Marconi has, however, himself achieved so great success in syntonised wireless telegraphy, that he can well afford to take a generous view of the labours of his contemporaries in the same field, without striving to bring them all within the scope of his own inventions.

SMOKE AND GRIT FROM ELECTRIC LIGHT AND FACTORY CHIMNEYS.

Can Smoke be Recorded, and Practically Diminished?

By a MEM.I.C.E.

II.

In this article we propose to continue our remarks as to the practical possibility of diminishing the duration and intensity of the smoke now too often seen from electric stations and factory chimneys.

Most engineers know, but do not always acknowledge, that black smoke is a preventible evil, and that its abatement would generally conduce to the saving of money and fuel. What is really needed is to take measures to improve the combustion. Black smoke is an effect, not a cause, and its diminution would naturally follow if this cause, namely, imperfect combustion, were removed. Owners of factories are generally of opinion that they cannot help the black smoke which issues from their chimneys, but in this they are usually mistaken. In reply to the arguments so often brought forward, let us hear what the best authorities have said upon the subject.

The late Mr. Fletcher, formerly the able chief inspector of the Manchester Alkali Works, issued in 1895 an excellent report of the work done, and the data obtained, by a committee formed with the express object of testing smoke-preventing appliances. This independent and important

committee was brought together for the purpose of determining how far black smoke, from factory and other manufacturing chimneys, could be diminished or prevented with various types of boilers. The object of the movement is set forth in the original report as follows:—Those interested in it came to the conclusion that "a great step towards smoke prevention would be made if manufacturers could learn, on trustworthy authority, that suitable smokeless furnaces exist, and could obtain information from users, rather than from makers, as to efficiency, cost, and economy in working. It would also tend towards the same desirable end if local authorities and magistrates were provided with accurate information as to the kinds of manufacturing processes, in which it has been proved that the production of smoke can be economically prevented. To this end the committee set about, firstly, collecting and arranging the results of past experience; secondly, making examinations and tests by the aid of experts."

Further, the report states that "the problem to be solved is that of effecting the complete combustion of coal with a minimum of air; in other words, of completely using all the air that is supplied." The admission of too much air to the grate is always attended with the cooling of the boiler and waste of heat up the chimney, and thus causes waste of fuel. Too little air, on the other hand, nearly always means black smoke after each stoking of the furnace, and bad, that is incomplete, combustion. If there is to be no black smoke, a certain excess of air is necessary. Everything, however, remains in doubt and uncertainty till the gases of combustion are sampled and analysed. Hence the great importance of this simple and inexpensive process, by means of which we can find out the percentage of free oxygen, as well as of the carbon monoxide and carbonic acid in the gases. We are able in any particular case to know how good or how bad combustion is, and whether the right amount of air has not only been supplied, but utilised in the furnace.

A great many experiments were made by the committee, and the results obtained were published in great detail, together with tables giving the temperature and analysis of the escaping gases, and observations on the colour and duration of the smoke emitted. About 70 experiments in all were carried out, most of which lasted the whole day, and some of them many days. It was found that in 12 examples of hand-fired boilers, the air being admitted in front and at the back of the furnace, the average duration of smoke was about 90 minutes. With four kinds of sprinkling stokers the average time during which smoke was emitted was 106 minutes, while with 21 coking stokers the time was only 16 minutes, a day of 10 hours being taken as the standard in each case. Thus coking stokers are first in respect of power and economy, and six of them were altogether the best; the furnaces served by them evaporated more water per pound of carbon than any of the others, and the analysis of their waste gases gave a better percentage of CO_2. "This," the report says, "shows that the action of the machine was attended by the letting in of less unnecessary and heat-absorbing air than any of the other machines or systems." . . . "At Messrs. Brunner & Mond's Chemical Works, Northwich, a range of over 50 boilers, with mechanical stokers and three chimneys, are nearly smokeless." With the hand-stoked grates the results varied much. The duration of the smoke was only 16 or 17 minutes in two of these, when the stokers were aware that their chimneys were under observation, but as soon as this check was removed the amount of smoke increased four to eight-fold.

The Glasgow branch of the Commission state as their opinion that "whilst future experiments and inventions may be the means of introducing new and better methods of treatment in the combustion of fuel, enough is known at present to enable steam users to work their boilers with a fair degree of economy, and practically without smoke." After a series of careful trials during five consecutive days, the Sheffield branch give their views as follows:—"That a Lancashire boiler with a moderately good chimney draught can, with a careful stoker, be effectively fired by hand with small clean coal, and with only the most ordinary and common place appliances for regulating the admission of air, without creating any considerable amount of smoke, and certainly with only a very small percentage of dense black smoke." Nor does this apply only to the case of Lancashire boilers. The discharge of black smoke into the air is, they say, unnecessary and wasteful. "A manufacturing district may be free from manufacturing smoke—at least from the steam boilers." As to the means by which it may be so freed, Mr. Fletcher's able report contains ample information. Surely such clearly expressed opinions from an independent Commission should enable any magistrate, if he takes the trouble to read the report, to decide the cases of smoke nuisance brought before him, and whether the smoke is preventible or not. He should also be able to determine whether there has been any special negligence on the part of the stoker or chimney owner. This is an important point. Smoke is often produced by the attempt to burn too much coal per square foot of grate surface, or coal of inferior quality, or containing much fine dust.

Mr. Kent, a well-known authority in the United States, expresses himself still more emphatically on the subject in his new book on "Steam Boiler Economy" (1901). "All of the loss due to smoky chimneys," he says, "it is quite possible to avoid by the use of well-known and well-tried appliances. The principles which govern the complete and smokeless combustion of bituminous coal are simple enough, but the application of these principles in practice has hitherto been usually considered to involve extra cost of installation of a boiler plant, extra cost of repairs, and extra trouble. The fear of extra cost and trouble, together with the exceeding conservatism of factory owners in regard to everything connected with steam boilers, have been the chief obstructions to the universal use of smokeless furnaces." Coal can, he considers, be burned without smoke if the gases are slowly distilled, brought into intimate connection with hot air, and burnt in a hot fire-brick chamber. Further, while burning, they must not be "allowed to come in contact with comparatively cool surfaces, such as the shell or tubes of a steam boiler," but should have sufficient space and time to burn before such contact is permitted.

As regards stoking, Mr. Kent is of the same opinion as the English Commission, namely, that the coking system is the best. It is essential that the whole bed of the fire shall not be covered at the same time with fresh fuel. With the coking method the coal is piled up either by hand or by a mechanical stoker, in the front part of the fire, while combustion is actively proceeding in the rear. The gases from the freshly distilled coal are forced to pass over the bed of glowing coke at the back, where they meet a current of hot air entering from behind, and the two currents intermingle in the hot combustion chamber. After the gases from the front part have been thus distilled off, the coal is spread carefully over the glowing bed of fuel in the rear, fresh coal is supplied to the front, and the process repeated. With coal containing much ash this method is unsuitable, but for ordinary soft coal it ensures good, and almost complete, combustion. Much, of course, depends on the skill of the stoker, and the size and arrangement of the combustion chamber. "The smaller the quantity of fresh coal fired at a time," says Mr. Kent, "and the greater the care exercised by the fireman to keep the quantities fired each time and the intervals between firing uniform, and to keep the bed of coal in the rear level, and not too thick, the less will be the amount of smoke. The larger the combustion chamber in which the currents of smoky gas and of hot gas surcharged with air unite, the longer time will be afforded for their admixture, the more complete will be the combustion, and the less will be the smoke."

A committee was formed in 1891 by the St. Louis Engineering Club, U.S., to consider the question of smoke prevention and smoke consuming appliances. These they divided as follows into (1) steam jets, (2) fire-brick arches or chequer work, (3) hollow walls for pre-heating the air, (4) coking arches or chambers, (5) double combustion furnaces, (6) downward draught furnaces, (7) automatic stokers.

The chief inspector of the Local Government Board in Scotland, in his report for 1892, is also of opinion that "consumers of coal . . . . can prevent the discharge of black smoke from their chimneys." Merely to admit an excess of air is not, however, sufficient for this purpose, for the blackest smoke is sometimes given off by furnaces in which there is an excess of air. As already explained, the

air must be thoroughly mixed with the gases, and a very high temperature is necessary. "In short," says the report, "there must be, firstly, a sufficiency of air; secondly, that air must be brought into contact with the fuel, both solid and gaseous; and thirdly, the mixture of the gases and air must be maintained for a sufficient time at a temperature of incandescence. These conditions are simple, but the necessity of providing them is not always kept in view."

Foreign opinion is equally unanimous on the subject, which has engaged much attention in France and Germany. The reports of the Prussian Smoke Commission of 1894, and of the Paris Smoke Commission of 1898 may be studied with advantage; in the latter the smoke observations were most carefully carried out every few minutes for a whole day. The German Engineering Association have also devoted much thought to the question of smoke prevention, and have formulated the conditions for good combustion as follows:—(1) The grate must be suited to the kind of fuel burnt, and the working conditions; (2) practical uniformity in the quantity of fuel burnt at one time; (3) sufficient draught; (4) careful and skilful stoking; (5) a chimney high enough to carry off the products of combustion.

Grit.—We must now say a few words as to the emission of grit from electric light stations and factory chimneys. This is a more modern nuisance than the smoke, and it has, unfortunately, a tendency to increase, owing to the new methods of stimulating the chimney draught by mechanical means. The latter process is carried out in two ways, by either forcing air under the grate, or by drawing or sucking the hot gases from the boiler. Both these methods are now often used together. The speed of the gases up the chimney, and the draught, are thus considerably increased, the object being to burn more coal under the boiler, and to evaporate more water. The result is that small unconsumed particles of coke and light ash are carried upwards, and necessarily fall as they leave the chimney on the surrounding roofs, gardens, buildings, &c., according to the direction of the wind. These small pieces of black ash, about 1 to 2 millimetres in diameter, are very often found in the immediate neighbourhood of such chimneys. In and about large railway stations the roofs and gutters are partly covered and more or less choked with them, as any careful observer can see for himself. In these localities they are due to the forced draught up the chimneys of the many locomotives constantly passing. Traps in the horizontal portion of the main flue from fixed boilers, where the speed of the gases is slower, can be so arranged as to catch the grit, so that this particular nuisance may be got rid of at small expense if there is a genuine desire to do so. The smaller the size of the coal used, the greater the quantity burnt per square foot of grate, and the more the draught is forced the larger will be the quantity of grit ejected from the chimney. On the decks of steamers this unpleasant deposit is often seen, but here it is of less importance than in cities and towns.

As compared with the smoke, grit is perhaps a minor trouble, but both, as we have endeavoured to show, can be much diminished if the work is seriously taken in hand. Scientific knowledge is not always required from the owner of the chimney, but he will do all the better for a little technical supervision from an expert, such as ought now to be easily procurable.

LOCALISATION OF HIGH RESISTANCE BREAKS.

By J. RYMER-JONES.

(*Concluded from page* 962.)

Example.

Let the ratio between the measured charge of the broken cable—equivalent to a capacity f—and the calculated charge of the imaginary cable — equivalent to F microfarads—viz., $\frac{f}{F} = 0{\cdot}325137$, *i.e.*, the former is 0·325137 of the latter whose full capacity for holding a charge is represented by 1 (see Table I., col. 14), or $\frac{325{,}137}{1{,}000{,}000}$, when the full charge is represented by 1,000,000 (see cols. 12 and 13).

Referring to Table I., we find the nearest value 0·277,500 (col. 14), or 277,500 (in col. 13), opposite to the length 150 miles (col. 15); and for the excess, viz., 325,137—277,500 or 47,637 we must look along the 5-mile sections of the next 50 miles (in the line above), more distant from the testing end for the nearest value. This we find under col. *d*. viz., 41,875, which is the sum of the static charges in the first 25 miles of the next 50 miles beyond the 150 already noted. There still remains a difference of 47,637—41,875, or 5,762. The equivalent length for this additional charge is found by means of Tables II. and III.

It must be borne in mind that it is beyond the 25 of this particular 50 miles, *i.e.*, beyond the 175th mile from the testing end, but not so far as the charge held by the next 5 miles would give, otherwise the excess of charge sought for would have been found in Table I. at or beyond the 30th mile, *i.e.*, 150 + 30, or the 180th mile. It is evident, therefore, that the extra charge required will be somewhere in the 5 miles beyond the 25th, but not so far as the 30th mile, viz., 50,100. We must refer, therefore, to the 25th to 30th-mile line of Table II. But the values in Table II. are correct only for the 50 miles farthest from the testing end, *i.e.*, where the imaginary cable is earthed, and a *constant*, given in Table III. for every 5 miles according to its position in the cable, has to be added to make Table II. applicable.

Thus the position we are now dealing with, approximately 175, is between 150 and 200 miles from the testing end (see Table III., col. 24), opposite to which in cols. j^1, k^1, l^1, m^1, n^1, are the *constants* which have respectively to be added to the sub-divisions of the 5-mile values in cols. j, k, l, m and n, according as it is the additional charge for 1, 2, 3, 4 and up to 5 miles which is sought for.

In the present example this quantity is 5,762. Referring, therefore, to the *constants* in Table III., on the same line as 150 to 200 miles, we find, under the 3rd-mile col., 4,800, to which must be added 141, given in the same 3-mile column of Table II. on line 30 to 25 miles. Together these equal 4,941.

The approximate position of the break along this imaginary cable of 1,000 miles when $\frac{f}{F} = 0{\cdot}325137$, is therefore 178 miles from the testing end, made up as follows:—

150 miles	holding a charge of	277,500,	see Table I., col. 13	
25	„ „	41,875,	„ col. *d*	
3	„ „	4,800 141	4,941,	„ II. and III. in the 3 miles col. on the 30th to 25th-mile line.
178	„ „	324,316		

There is still, however, the difference 325,137 — 324,316 viz., 821 to be evaluated. This 821 represents part of the charge in the 179th mile, the full charge of which is found also from Tables II. and III. On the same line, with 150 to 200 miles, the constant for 1 mile in this part of the circuit is given as 1,600 (Table III., col. 24), to which has to be added the extra 43 of Table II., col. 17, on the 30 to 25-mile line. Together these give 1,643 as the total charge of the 179th mile. Therefore, the additional length represented by 821 is $\frac{821}{1{,}603}$, or 0·5 mile. The full calculated distance of the break then is 178·5 miles from the testing end of the imaginary cable 1,000 miles long. But the *real* length of the circuit represented by the cable conductor and fault resistance is $\frac{R\,l}{r_1} = L$ nauts. Therefore the actual distance x of the break is $178{\cdot}5\ \frac{L}{1{,}000}$ nauts.

If L = 500 nauts,

$$x = 178{\cdot}5\ \frac{500}{1{,}000} = 89{\cdot}75 \text{ nauts.}$$

Correcting the Calculated Distance of the Break for any Revised Value of the C.R. and Capacity per N.M.

The distance (x) of the break is strictly correct only when the C.R. and capacity employed for the calculation are the

mean per N.M. of the *ruptured portion* under test. Until the approximate distance is found these will not be precisely known and a correction may be necessary.

Thus the C.R. per N.M. (r_1) taken is the mean for the whole unbroken cable as obtained from recorded measurements. As the greater part of this may be in deep and, therefore, cold water, and the ruptured portion in shallow or warmer water, the mean resistance per N.M. (r_2) of the latter will be higher. What this is may be determined by reducing the mean *factory* C.R. per N.M. at 75° F. of the unbroken cable—or, better still, of the ruptured portion—to the observed or estimated temperature of the average depth of the broken part.

If $r_1 = 10{\cdot}4^{\omega}$ and the revised value $r_2 = 10{\cdot}8^{\omega}$, then r_2 is 3·85 per cent. greater than r_1, and the revised length L_r being less, viz., $\frac{R\,l}{r_2}$ will make the capacity F_r 3·85 per cent. less than F.

Again: If the mean capacity f_1 for the whole unbroken cable differs from the mean of the ruptured portion—as obtained from the factory values of the completed cable—F must be also corrected for this revised value, f_2.

Let $f_1 = 0{\cdot}33$ mfd. and the revised value $f_2 = 0{\cdot}35$ mfd.; then f_2 is 6·06 per cent. greater than f_1 and the value of F_r, viz., $L\,f_2$ will consequently be 6·06 per cent. greater.

If both the C.R. and capacity correction be + or both −, F must be corrected for their *sum*; or if one be + and the other −, the correction will be for their *difference*.

In the above case these values are − 3·85 per cent. and + 6·06 per cent., which means that F has to be corrected for their *difference* + 2·21 per cent., *i.e.*, increased by that percentage.

Increasing F means decreasing the ratio $\frac{f}{F}$ by the same amount; therefore, the ratio 0·325137, which in the foregoing example was found to represent a distance of 89·75 N.M., has to be decreased by the above 2·21 per cent., which gives a revised ratio $\frac{f}{F_r} = 0{\cdot}318{,}107$ or $\frac{318{,}107}{1{,}000{,}000}$ of the total charge held by the imaginary cable of 1,000 miles.

Referring this value to Tables I., II. and III., as explained, we get :—

150 miles holding a charge of			277,500,	see Table I., Col. 13.
20 „	„	„	33,600 „	„ Col. *c*.
4 „	„	6,400 224	6,624 „	Tables II. and III. in the 4 miles col. on the 25 to 20-mile line.
0·23	„	„	383°	
174·23	„	„	318,107	

The actual distance

x_r (as revised) $= 174{\cdot}23\,\frac{L_r}{1{,}000}$ and supposing $L_r = 481{\cdot}5$ N.M.

x_r „ $= 174{\cdot}23\,\frac{481{\cdot}5}{1{,}000} = 83{\cdot}89$ N.M.

General Remarks.

The cable or earth current, whether + or −, does not alter the charge held by the cable, because, although in effect it apparently increases or decreases the measured resistance, according as it opposes or reinforces the testing current; and a change in these currents will also upset the balance; yet this apparent change in the resistance is equal in every part of the circuit, including the cable conductor, fault and shunted galvanometer coil g_1; consequently the potentials at the two ends of the cable conductor remain the same. For example: If the apparent resistance be reduced to one-half owing to the cable current and testing current being in the same direction, the fall will be doubly abrupt, but the potentials at the two ends of the cable portion will remain the same as if no cable current existed and the charge throws will therefore be equal. On the other hand, a *real change* in the fault resistance, due to the testing battery opening or sealing the fault, would alter the degree of fall, and consequently the charge in the cable. Hence it is important that the actual fault resistance remain constant.

If the balance be steady it will show that the fault resistance and cable current are steady; but if R (or the adjustable shunt) has to be varied much to maintain the balance, the value of R and R l should be re-determined by observing d and δ at the end of the series of charge observations (C). The degree of constancy in the balance serves as a valuable indication as to the steadiness of the fault resistance, and therefore the reliability of the cable charge readings.

The true resistance of the cable branch R l and the cable charge C would be more directly obtained if one or two constant cells, shunted by a suitable low resistance rheostat, be placed in the cable circuit between b_1 and b_2 to counteract and balance the cable current, and the galvanometer coils g_1 and g_2 are exactly equal in effect and resistance and similarly shunted. Under these conditions R would equal the actual resistance of the cable circuit, and as only a few seconds would elapse while discharging the cable by K_2 (as explained) preparatory to observing the charge throw (C), the fault resistance is less likely to change.

A suitable rheostat would, however, not always be available, nor the fault current always remain the same when the testing current is on or off. This introduces extra trouble, uncertainty in the equilibrium, and the real value of R t. In practice, therefore, it will be preferable not to attempt to balance the cable current, but confine one's attention to balancing with R (or the shunt on g_2) and to measure R t separately by direct deflection as already explained.

Galvanometer.

It is desirable to employ a ballistic galvanometer, or one with a heavy suspension, on account of the capacity test, and the spot should return quickly to zero.

If only an ordinary astatic reflecting galvanometer be available, the coils should be connected up differentially; and the fact that two opposing coils will not have exactly the same effect on the suspension will not signify, as the inequality can be compensated by the resistance R, or adjustable shunt. The writer has for this test varied the relative position of the opposing coils of an astatic galvanometer, which happened to be hinged, by fitting spiral springs on the spindles of the screws intended to close the coils, and using the screws as a fine adjustment, so that the coils (of equal resistance) had an equal effect on the suspension as if they were doubly wound. But this equalisation of the effect is only necessary when the method of balancing the cable current is adopted.

A magnetised pen-knife, or preferably a small electromagnet placed near to the galvanometer, and energised by one or two cells and a reversing key close to the hand of the operator, will be of great assistance in bringing the spot quickly to zero after being deflected.

The test is not so certain for board-ship use owing to the rapidity of the throw on a marine galvanometer suspension, when charging a cable or condenser, necessitating several successive readings to make sure of the deflection. In other respects the test is as applicable as on shore.

If the Kelvin ironclad marine galvanometer be used, the two coils may be connected up to act differentially when required for this test: or they will be more suitable still if doubly wound.

A Sullivan marine galvanometer is much more serviceable on account of its being dead-beat, its low resistance, greater sensitiveness and more readable throws.

A coil for this galvanometer can be doubly wound to make it truly differential. The usual tense phosphor bronze wires at the top and bottom of the frame are used for one end of each of the opposing coils, and the connection with the junction between the other ends of the coils is through a fine and wide spiral wire (as used for the more sensitive Sullivan galvanometer constructed for testing on shore), which encircles but does touch the lower suspension.

ADDENDUM.

This test is applicable for breaks of low or very high resistance, but has been especially designed for the latter, as other tests in common use are better suited for breaks of

° The total charge for the 175th mile is 1,651, viz., the constant 1,600 for 1 mile opposite to 150 to 200 miles in Table III., col. 24, plus the additional charge 51 on line 25 to 20 mile, Table II., col. 16.

very low resistance, because the charge taken up by the distant portion of the broken cable would be small for very exact measurement. To prove the accuracy of the *principle* on which this test is based, the writer employed an astatic reflecting galvanometer joined up differentially, an artificial line having a conductor resistance of 285 ohms and 36·6 microfarads, and the fault had a (wire) resistance of 20,000 ohms. The result obtained was 281·5 as the distance of the break. Another test made under the above conditions, but with a *fault current* in the line of 1·5 volts gave a ratio $\frac{f}{F}$ identical with that obtained without a foreign E.M.F. in the line; consequently the resulting distance was the same in both cases. A cable-laying expedition has prevented the writer from including in the present description results on actual breaks in a cable core which he must defer till a later date.

ON POLYPHASE GENERATING AND SUB-STATION PLANT FOR ELECTRIC TRACTION.

By A. C. EBORALL.

(Concluded from page 965.)

THE differences in the fly-wheel effects indicated above are very great, but are by no means exceptional, for most electrical contractors come across similar differences (perhaps on a smaller scale) nearly every day. In the above instance, quite apart from the question of steam consumption, it is clear that the Continental engine is by far the best for the work in question, for the amount of fly-wheel effect required in order that a given cyclic irregularity may not be exceeded is really a measure of the quality of the design of an engine, as the question of steam distribution, balancing and arrangement of the parts, &c., all come into consideration. In the present case the triple-expansion engine presented the distinct advantage of having a much smaller cyclic irregularity with a comparatively light magnet-wheel, which latter point is in itself a condition favourable to good parallel running. Again, although this engine was the most expensive of the three, yet the cost of the combined set came out nearly the same as that of engine (*a*) and its generator, on account of the increased cost of the latter, due to the enormous fly-wheel effect that had to be arranged for in its magnet-wheel.

It is these enormous fly-wheel effects that Mr. Hobart objects to, and quite rightly; the writer considers, however, that the excessively heavy magnet-wheels (or fly-wheel effects), which are the most prominent features of English and American low-speed engines, should be unnecessary, and a comparison of such engines with Continental engines proves this. It would appear that too little attention is paid to the design of valves, position of cranks, and general design of the engine from the point of view of cyclic irregularity, and that the shortcomings in these respects are more or less compensated for by providing enormous fly-wheels. Continental firms, on the other hand, have gone to work in the opposite direction, starting from the points of steam distribution and crank angle, with the result that for work of the same character better parallel running is obtained with comparatively light magnet-wheels. Such firms as Sulzer, Ringhoffer, Augsburg-Nürnberg Machine Works, Carels, Borsig, Görlitz, &c., have brought the very highest scientific knowledge to bear upon the problems of engine design to suit the conditions of polyphase working, one result of this being as above set forth, the other being that the figures obtained for steam consumption (even without superheating) cannot be equalled by English or American builders.

It is noteworthy in this connection that the use of Corliss valves on the *high-pressure* cylinders has almost disappeared on the Continent in favour of balanced lift valves. The writer is by no means prepared to admit that the apparent complication of such valves presents disadvantages worthy of any serious consideration whatever, and thinks that it is time some of the Continental valve gears (such as Collmann's) were given a chance in this country, in place of the Corliss valve gear nearly universally used with large British engines.

In disagreement with Mr. Hobart, then, the writer does not consider that there is any reason whatever to discard rotary converters in favour of motor-generators, simply because the engine requirements for satisfactory parallel working are difficult to fulfil. On the contrary, he is convinced that this can be done without excessive cost, and with moderate fly-wheel effects—the example given above (5,000-H.P. engine with magnet-wheel of 45 tons) is a proof that sufficiently good turning can be obtained for rotary converter work, without a "tremendous" fly-wheel. The writer could cite many other instances, as could other engineers whose daily work lies in this direction. It seems to the writer that the better course is to try and convince the engine builders in this country that it will well repay them to turn out engines better suited to the work under consideration, rather than to give up the use of a well-tried type of converting machine in favour of one by no means as well fitted for the work to be done.

With the phase displacement given above (2°), the losses in the damping coils of properly designed rotaries are nothing like the 2 per cent. put forward by Mr. Hobart; they will be of the order of $\frac{1}{2}$—$\frac{3}{4}$ per cent. The following comparison can then be made between the efficiencies of a tramway sub-station equipped with the two different classes of converter, 500-KW. sets being considered.

	Rotary converter sub-station.	Motor-generator sub-station.
Full load efficiency ...	92 per cent.	... 87 per cent.
Half „ ...	87·5 per cent.	... 79 per cent.

These figures are not calculated, but based upon experience obtained with sub-station plant, working from power stations equipped with steam generators conforming approximately to the writer's recommendations. The efficiency in each case is taken to be the ratio of the direct current output to that of the polyphase current input observed on the high pressure side. Thus for the rotaries the losses in transformers, damping coils, and auxiliary reactance coils (for use with the compound windings) are included; the synchronous motors had solid pole shoes and no damping coils.

The difference is 5 per cent. at full load, against the 2 per cent. stated by Mr. Hobart; at half-load (and this load must be considered when dealing with tramway sub-stations) it is 8·5 per cent. The difference is so great that its effect on the economical working of a large system would be enormous, as can be seen at once by anyone working out the two schemes side by side.

Of course, any large electric tramway scheme in this country, if approximately well designed and well managed, will pay well, but this is no reason why it should not be made to pay better, by endeavouring to secure the highest possible economy all over the system—as *the whole* of the power has to be converted by the sub-stations, these should obviously be made as efficient as possible.

Regarding the relative first cost of the two classes of sub-station equipment, the writer agrees with Mr. Hobart that there is comparatively little difference when everything is taken into account; the same remark applies to the amount of space required. But regarding the relative amount of attention necessary when running, the two types are on a level with one another. For with large work, a fairly skilled attendant has to be in the sub-station anyhow—as long as things go right he will have practically nothing to do in either case, as all the regulation is automatic for tramway work, whatever the type of machine employed. So that here again the writer ventures to join issue with Mr. Hobart, while agreeing, however, that for simplicity of working, the synchronous motor-generator sub-station has some slight advantages.

The writer quite agrees with Mr. Hobart as to the cause of the hunting of synchronous sub-station machinery. If the turning moment of the engines is sufficiently uniform, and the engine governors are provided with suitable dashpots, so that they are unresponsive to short quick changes in speed, there will be no hunting of the sub-station machinery. This was a point fully discussed in the Institution paper already referred to. At the same time, there are certain definite causes that tend to set up hunting, such as short-circuits,

faulty setting of the brushes of the rotaries, hunting of an engine governor, unbalanced phases, &c., and that is why it is necessary that all rotary converters (whatever the frequency and whatever the engine speed) should be provided with damping coils. For these damping coils (under the above assumption of suitable engines) will check the oscillations of the rotaries as soon as they are set up. If the engines are unsuitable, however, (that is, if the phase deviation is, say, 4°—5°) it may not be possible for the damping coils to check the oscillations properly, the result being unstable running accompanied by heavy losses in the damping coils and frequent flashing over at the commutators.

Mr. Hobart, in the article referred to, does not state that synchronous motor-generators are less likely to hunt under given conditions than rotary converters, but this is really the case. It is for this reason that the writer fails to see the necessity for reducing the supply frequency to eight cycles, or thereabouts, for any well-designed synchronous motor will operate perfectly well at 40 cycles, the losses in the solid pole-shoes or damping coils (due to the oscillations) being, as a rule, insignificant with any standard type of first-class engine. Polyphase generators and synchronous motors for very low frequencies are not so good as those of standard frequency, machines for 40—50 cycles being somewhat cheaper, and electrically better. As a matter of fact, one great advantage of synchronous motor-generators is that, by their use, a normal supply frequency, with its accompanying advantages, can be used all over the system.

The fact that synchronous motor-generators run better in parallel than rotary converters under given conditions, does not seem to be well recognised, several writers having stated that there is no difference between the two classes of machinery in this respect.* Practice, however, shows otherwise, and a somewhat larger phase displacement may be allowed for steam generators feeding synchronous motor-generator sub-stations, than for those supplying rotaries. The reasons seem to the writer to be perfectly clear. It is common experience that all synchronous machinery runs better in parallel when loaded than when running light, for the rotating parts do not oscillate so freely on account of the resistance to change of velocity offered by the load—thus, for instance, considering the most favourable case that could arise, a synchronous motor driving a centrifugal pump would never hunt, as the load would strongly resist any changes in the angular velocity. Now a rotary converter presents the paradox that, even when fully loaded, there is practically no load on the shaft, as the driving action on the one side balances the driven action on the other. Consequently, there is nothing to offer any resistance to the oscillations, and the rotary converter when fully loaded is in much the same position as the synchronous motor-generator running light—more unfavourable, in fact, for the no-load losses of the latter machine are greater. Then, again, the armature reactions of synchronous motors tend to prevent the shifting of the field flux from the pole faces into the gap between the pole horns, and thus tend to check the oscillations; moreover, with synchronous motors the field system is always fed at a constant steady pressure, while with rotaries any variation in the pressure on the direct current side directly influences the field strength, which is probably an unfavourable condition. For these reasons, synchronous motor-generators are far less subject to hunting troubles than rotary converters.

Mr. Hobart raises an interesting question in connection with the mechanical design of synchronous sub-station machinery; he states that this should be specially arranged to have large momentum, as this is a condition unfavourable to hunting. On this point, also, the writer is not inclined to agree, for hunting is purely a mechanical effect, the armatures of the machines actually swinging over a fixed point in space. The amplitude of these swings must be dependent upon the moment of inertia of the armature and upon the field strength, and therefore should oscillations be set up they are the more easily checked by the damping coils the smaller the moment of inertia. Not only this but the natural period of swing of the armature will be longer the larger the mass, and therefore the periodic engine impulses are more likely to set up hunting than would be the case if the rotating mass was small.

The writer will not further discuss this interesting and important point now, as he is at present conducting an investigation on the subject, the results of which will be published as soon as definite conclusions have been reached. But before leaving it, it may be pointed out that Mr. Hobart's argument regarding this question of momentum is apparently somewhat illogical, for on the one hand, he advocates the use of motor-generators instead of rotaries in order to save expensive engine fly-wheels, while on the other hand, he recommends specially large momentum for the motor-generator armatures, which would come to the same thing. So that even if Mr. Hobart's reasoning as to the cyclic irregularity of low-speed engines be taken as correct, it would appear preferable to keep to standard practice with regard to tramway sub-station work—that is, employ 25-cycle rotary converters fitted with choking coils—from considerations of economy and over-load capacity, as discussed above.

Finally, the writer would like to put forward the following *general* conclusions relative to sub-station work in general, it being assumed that it is necessary to convert the polyphase current into direct current by means of converting sub-stations:—

1. For tramway and railway work, and for those cases where the amount of lighting to be done is relatively small, rotary converter sub-stations operated at about 25 cycles, will give the best results, whatever the type of engine.

2. For lighting work, the use of motor-generators operated at 40—50 cycles in the sub-stations, will give the best results. This is also the case when the lighting load on the sub-stations forms the greater proportion of the total output of the latter.

Of course, for industrial power work of large magnitude, or for such power work combined with lighting, spread over a large area, it is hardly conceivable that any experienced engineer would lay down nowadays any system but a polyphase system throughout—preferably three-phase.

* See, for instance, the *Electrician* (leading article), April 19th, 1901.

SUPERHEATED STEAM.

By W. H. BOOTH.

Engineers seeking information on superheated steam may read with advantage a paper recently presented by Mr. E. H. Foster to the American Society of Mechanical Engineers. From this it may be gathered that superheat is not much employed in America, though Isherwood recommended its use in his second volume of "Experimental Researches," and stated its economy at 33 per cent.

In the early days of superheat, about 1850, it was found to give an economy of 30 to 40 per cent., but was abandoned because of its bad effect on the lubricants of that period.

Mineral oils, however, have given very different results, and superheat can be worked as high as 700°. It appears to the writer, however, that a great deal can be got from 100° of superheat, for this implies first that the steam is not wet, and mere wetness is in itself so wasteful as to make it worth while to superheat even 5° at the engine to ensure the steam being dry. Mr. Foster notices that European practice is decidedly in advance of American. Much of this is due to Hirn and to his successor Schwoerer, and there are many installations to attest the benefits of superheating which show economies of 6 to 20 per cent. The thermo-dynamic law is cited to explain the economy, but this is by no means the full explanation. The principal economy of superheat is that which accrues from the check placed on the effect of the cylinder metal. The inner surface of a cylinder absorbs heat from the entering steam, and gives it off to the exhausting steam, or rather to the water. If the exhaust is dry, its heat absorbing property is poor; if the exhaust steam cannot absorb heat from the cylinder, the cylinder must of necessity remain hot, and if the cylinder remains hot it cannot, obviously, absorb heat from the entering steam. This is the main economy to be

got from superheat, and superheat has this advantage over the steam jacket, that the heat is applied when and where it can do most good. Often, indeed, the steam jacket appears to be of negative benefit. Probably when this is the case, it has been badly designed, as it often is, but there can be no mistake about superheat if we have it. It will do its duty to the full extent of its opportunities. If we can safely apply so much superheat as to produce a dry exhaust, then there can be no room for any jacket, and Mr. Foster sees this, and also that superheat may even reduce the number of cylinders in compound work, and enable compound engines to be employed where now triple-expansion is thought necessary, especially as there are already records of an 800-H.P. engine being run for as little as 10·12 lbs. of steam per I.H.P.-hour, the engine being compound only. In regard to electric traction Mr. Foster says nothing, but it is certain that no more promising field for superheated steam can be found than in a traction station. In a previous article it has been shown by the writer that the load factors on small and moderate stations are so very poor that when compound engines are employed they must be very large to enable them to carry the maximum load at full steam admission, and therefore they must be seriously underloaded at the mean load and ridiculously large for the loads below mean. If, however, a simple engine be employed for such work, it can be made of half the size of the compound engine, and will still deal with the maximum loads, and will not be so very seriously underloaded at mean loads. It is certain that a simple engine with superheated steam is the proper engine to employ for cases of poor load factor, especially where there is no accumulator. Mr. Foster discusses the material of superheaters, and states that he has found during his European tour superheaters of cast-iron that have been in use for six years without showing signs of deterioration, and he inclines generally to cast-iron as a material for their construction, believing it to be more durable, and that being heavier and thicker than wrought-iron or steel pipe, there is a steadying effect upon the degree of superheat given to the passing steam. Moreover, the objections to cast-iron as a material for boilers do not apply to superheaters, which contain no water and are not liable to uneven temperatures in their different parts.

In large plants Mr. Foster has found the superheaters to be placed in a battery with the boilers and fired direct like a boiler, a fact that is in itself a sufficient testimony to the benefit of superheating.

CURRENT SPECIFICATIONS.

LXVI.—BARKING CONDENSING PLANT.

SUMMARY.

Extent of Contract.—Supply and erection of surface condenser, cooling tower, electrically-driven air and circulating pumps, together with necessary pipe work.

Size of Condenser.—To be capable of taking care of 15,000 lbs. of exhaust steam per hour.

Type of Condenser.—To have wrought or cast-iron case, with brass tubes, properly secured to allow for expansion and contraction.

Area of Cooling Surface.—To be not less than 1,800 sq. ft.

Fittings Required.—Usual hand valves, automatic atmospheric exhaust valve, three thermometers, and one vacuum gauge.

Type of Air Pump.—Preferably separate from the circulating pump, to be of ample size, and driven by a series-wound direct-current motor.

Type of Circulating Pump.—May be of centrifugal type if preferred, driven by a shunt-wound motor.

Type of Motors.—Both above motors to be suitable for use on either 230 or 460-volt circuit, resistances to be so arranged that the increase in speed, when the motors are transferred from 230 to 460-volt circuit, is small.

Type of Oil Extractor.—Extractor to be supplied to extract the oil from the exhaust steam before passing to the condenser, to be of a type which has proved thoroughly successful in actual use under similar conditions.

Type of Cooling Tower.—To be of either natural or forced draught type, as selected, to be capable of easily dealing with 45,000 gallons per hour.

Position of Cooling Tower.—To be placed on roof of boiler house; total weight to be stated when tendering.

If Forced-Draught Type, How Driven.—If fans are required, these are to be electrically driven, and similar, as regards voltage and control of speed, to those specified for the air and circulating pumps.

Specified Date of Delivery.—To be stated by tenderers; completion by earliest possible date is important.

Penalty for Late Completion.—1 per cent. of contract sum for either condensing or cooling tower plant per week that promised date is exceeded.

Specified Terms of Payment.—Up to 75 per cent. of work executed on site by monthly payments on engineer's certificates, until balance of 25 per cent. of executed work is equal to 10 per cent. of total contract sum. Thereafter 90 per cent. of work executed until work is completed. A further 5 per cent. to be then paid, and 5 per cent. 12 months later.

Period of Maintenance.—Twelve months from date of completion.

Stipulations as to Removal of Foreman.—Satisfactory.

Stipulations as to Wages to be paid to Workmen.—None.

Amount of Sureties.—To be stated in tender.

Arbitration Proposals.—Satisfactory.

Date of Receipt of Tender.—June 19th, 1901.

This specification has been prepared by the engineer and manager to the Barking Municipal Electricity Supply undertaking, Mr. A. Hugh Seabrook, A.M.I.E.E. It is divided into two sections, the condensing plant and the cooling tower being asked for separately. In some respects there is a marked difference between this and other specifications which we have from time to time examined. Instead of a number of instructions which must be obeyed under pain of disqualification of the tender, the requirements are simply stated and tenderers are expressly invited to make offers for their standard types of apparatus, stating at the same time what guarantees as to efficiency of working they are prepared to give. Time is expressly stated to be an essential part of each contract, and the earliest date by which completion of the work is guaranteed under a penalty of *1 per cent. of the contract sum* per week for delay beyond the stipulated time.

This course has much to recommend it, especially when the purchasing party has the advantage of sound technical advice. There is no doubt that offers made on standard apparatus must be cheaper than those demanding heavy expenditure in designing and making a number of new patterns, while there is the further advantage that there is less risk of breakdown in the use of tried apparatus. It would be an interesting study to find out how much money has been wasted in central station equipment alone in this country by the insistence of consulting engineers on fads and special designs for apparatus, which have only added to the expense while often detracting from the efficiency of the plant.

Mr. Seabrook has, in our opinion, served the interests of his employers well by suppressing the natural desire of a managing engineer to specify details of construction, and being content to leave the whole question of design to those whom it most nearly concerns—the manufacturers.

The general conditions are fair and reasonable, being based upon the model clauses agreed upon by the Municipal Electrical Association and the Electrical Plant Manufacturers' Association.

There is the usual provision for arbitration in case of disputes, and stipulations as to the limitations of the powers of the engineers, while the terms of payment may be accepted without demur.

LEGAL.

GWYNNE AND ANOTHER *v.* MEDICAL ELECTRO-THERMIC GENERATOR COMPANY AND ANOTHER.

THE hearing of this action was resumed on 6th inst.

Miss MOXON, a professional nurse who attended Mrs. Gwynne, said that before Mrs. Gwynne took the baths she had no experience of the hot air baths in question. On the first occasion, the defendants' nurse put the lint bags on the patient's legs. No explanation was given to her either on that or the second occasion as to the way in which to pack the patient. No lint was sent with the bath to Kenton Grange. Witness and Mrs. Gwynne's maid assisted in preparing Mrs. Gwynne for the bath on April 7th. They used the stockings as on the previous occasion, and put towels down the sides of the thighs. Between the patient's body and the nightshirt there was nothing but the asbestos. The heat from the top scorched her (witness's) eyebrows, and she asked Mr. Greville

whether the bath was too hot. Mrs. Gwynne complained of the heat at the top of her body, and that was reduced by means of a switch, the heat at the sides and bottom of the bath being unaffected.

In cross-examination, WITNESS said that on the occasion of the third bath she noticed that the asbestos did not come right up the sides as in the bath in Court; there was only a strip eight or nine inches wide up the middle. The towels were put in after Mrs. Gwynne was in the bath. Not knowing that the heat radiated from the bottom of the bath as well as from the top and sides, they did not pack the bottom of it. No lint was sent, and not knowing that it was necessary she did not ask for it. She was told that the bath would be sent ready for the patient to be put into it. The heat on one occasion in the third bath measured 320° on the thermometer. She was sure of that.

Re-examined: She had no doubt whatever that more of the body was in the bath on the third occasion than on the first and second.

EMMA GODBOLT, a maid to Mrs. Gwynne, gave evidence as to being present at Kenton when the bath arrived on April 6th. She was sure there was no roll of lint inside it. She was present when Mrs. Gwynne had the third bath. She assisted nurse Moxon to put the patient in the bath. She heard nurse Moxon tell Mr. Greville that Mrs. Gwynne was not so sensitive as other people to heat. She heard nurse Moxon say that her face was being scorched. She (witness) did not feel the heat herself.

Mr. JELF, in opening the defendant company's case, said that the issue was of great importance to his clients. Everybody would regret that the lady had suffered injury at the time she took the third bath. Both Mr. Greville and his son were extremely sorry for what had occurred, but that was a very different thing from admitting legal liability. He thought that when the jury had heard the evidence they would come to the conclusion that the plaintiffs ought not to succeed. The plaintiffs had to make out an affirmative case of negligence against the defendants, and this he submitted they had not succeeded in doing. The plaintiffs' case was that the defendants had been negligent in not sending the lint for use in the bath on the third occasion. Was it likely that these people who had got their reputation at stake, and who knew all about the difficulties of protecting the body, would fail to send the lint? He (counsel) would prove by evidence that a roll of lint was sent in the bath. When Mr. Greville, jun., arrived he found Mrs. Gwynne already in the bath. She had been put in the bath by Nurse Moxon, who, as he understood, was an experienced nurse, and who had seen the bath used on two previous occasions. Mr. Greville of course assumed that the proper precautions had been taken with regard to the use of the packing and the lint. It was ridiculous to suppose that Mr. Greville who, had his reputation at stake, would have said that everything was quite safe if he had known that the bath was not properly packed. The reason that the defendants did not send their own nurse with the bath was because Dr. Blasson, who took upon himself the responsibility of ordering the bath, said he thought that Nurse Moxon, who had seen the bath in use on two occasions, was quite competent to attend to the lady. Mr. Greville naturally acquiesced in this suggestion, and he (counsel) submitted that he could not be held to blame in doing so.

Mr. ARTHUR EDWARD GREVILLE, the defendant, a solicitor and also the inventor and patentee of the machine, said it had been used for about three years. It was in use at Leamington, Harrogate and Bath. In April, 1899, he should think that there were about 100 machines at work. On the second occasion when the lady was in the bath he was certain that lint was in the machine. When they sent a machine they always sent out a roll of lint with it. No machine had ever been sent out without a complete bottom covering of asbestos. When Witness saw Dr. Blasson on April 5th, 1899, the latter arranged that no nurse should be sent, in order to save Mr. Gwynne the extra expense.

Miss CHAPLIN, the nurse in the employ of the defendants who was present when the baths were administered on the first two occasions, spoke to Nurse Moxon being present when the lint was placed in the machine, and said that she explained the importance of the lint being placed at the bottom.

In cross-examination, WITNESS said she was not directed to give any instructions to Miss Moxon as to the way in which the bath was to be used.

Mr. HERBERT EDWIN GREVILLE, a son of the defendant Greville, and secretary of the defendant company, also gave evidence. He said machines were sent to private houses on an average once a day. It was always their custom to send lint, and it was sent on the present occasion.

Mr. ARTHUR WM. GREVILLE, brother of the last witness, said he was 22 years of age. At the time in question he had been superintending these baths for about a year, and had given close on 1,000 without accident of any kind. It was the duty of the nurse who was attending the case to place lady patients in the bath. He was sure the lint was sent. He administered the third bath. When he was admitted into the room Mrs. Gwynne was in the machine. He asked her whether she was quite comfortable and packed underneath. Mrs. Gwynne said she was. Witness put something under her feet. At the conclusion of the bath, Mrs. Gwynne said it was the best bath she had had, and she was perfectly satisfied with it. If he had been told no lint had come he would not have administered the bath without inquiry and without seeing the bath.

In cross-examination, WITNESS said he had never previously been out to attend a lady without one of their own trained nurses. He had no instructions to see that the patient was properly packed, and did not regard that as part of his duty. The highest temperature the bath reached was 280°, and that was reduced on Mrs. Gwynne's complaint.

This concluded the evidence, and counsel addressed the jury.

The hearing was adjourned.

On 7th inst. the LORD CHIEF JUSTICE summed up. He said the jury would have to consider whether the injury to Mrs. Gwynne was caused by the negligence of the defendant company's servants, including Mr. Greville, the managing director, and his son, who attended the bath, and whether there had been contributory negligence on the part of Mrs. Gwynne or her attendants. He did not consider that plaintiffs had made out any cause of action against Mr. Greville in his individual capacity, but the company were responsible for the acts of their servants. The jury, therefore, need not consider any question as to personal liability of Mr. Greville.

After nearly an hour's deliberation, the jury returned a verdict for the plaintiffs, with one farthing damages.

Mr. JELF asked his Lordship to deprive the plaintiffs of costs.

The LORD CHIEF JUSTICE declined to do so, but gave the defendant Greville his costs.

WELLS AND RAYNER *v.* ARTHUR SMITH.

IN the Westminster County Court on Friday, plaintiffs, electrical engineers of Paddington Street, Westminister, sought to recover £21 for electrical work done for the defendant at his house.

Defendant did not appear, and judgment was given for the amount claimed with costs.

POSTMASTER-GENERAL *v.* CORPORATION OF RICHMOND.

AT the Wandsworth County Court, on 4th inst., the Postmaster-General brought an action against the Corporation of Richmond for the judge's determination as to the Post Office being subject to the conditions proposed to be imposed by the Corporation in the matter of laying wires in the streets of Richmond, Surrey.

Sir ALBERT HUNTER, representing the Post Office, urged that as the Post Office were laying the wires for telephonic purposes in the streets, under an Act of Parliament, from which the public would obtain the benefit, they were not subject to conditions which the Corporation sought to impose upon them—viz., that if the positions of the cables had to be altered, the Post Office should pay for such alteration. This was in view of street widening.

Mr. MORDEN, on behalf of the Corporation, contended that under the Act of Parliament the Corporation were entitled to make these conditions as to the alterations being made at the Post Office's expense.

His Honour Judge RUSSELL held that the contention of the Post Office was correct. He did not think that the Corporation could impose the conditions they sought. He accordingly decided in favour of the Post Office.

ST. JAMES'S AND PALL MALL ELECTRIC LIGHT COMPANY *v.* BARNETT.

THE plaintiffs sought to recover, in the Westminster County Court, £3 from the defendant, who had been a customer of theirs at St. James's Street, S.W., and failed to give notice to cease the supply. Under the arrangement he was to pay 10s. if no current was used, and 5s. for the hire of meter. This payment was for the quarter, and plaintiffs contended that ran until notice was given. No notice was given.

DEFENDANT said he left, and the housekeeper was called, who said she gave notice to the meter reader when he took the index.

His HONOUR was of opinion that this was not notice within the meaning of the Act. The company had their Act, and they were entitled to recover the amount sued for with costs.

THE CUBA SUBMARINE TELEGRAPH CO., LIMITED, *v.* THE WEST INDIA AND PANAMA TELEGRAPH CO., LIMITED.

IN the Court of Appeal on Tuesday, before Lords Justices Rigby, Vaughan Williams, and Stirling, Mr. HALDANE, K.C., made an application on behalf of the defendant company to vary the minutes of the Order of the Court made on the appeal in the action. Learned Counsel said he did not think there was any substantial question of principle which divided himself and his learned friend, but a question had arisen as to the language to be employed on the drawing-up of the Order so as to rightly interpret the Order of the Court. No difficulty had arisen with respect to the definition placed by their Lordships upon the words "telegraphic communication," but upon the second point as to the nature of the injunction to which his learned friend was entitled, there was a difference as to the language to be employed. The injunction had reference to telegraphic competing messages, and the Order as drawn up was as follows: "And this Court doth declare that a telegraphic competing message means a telegraphic message originating in, or coming from, or going to any place with which the plaintiffs and any other company shall be in telegraphic communication in the ordinary course of business in such manner and at such rates as to make competition between plaintiffs and such other company practicable." He submitted that the words as they stood were too wide, and that the order ought to run, "telegraphic messages originating in and destined for places with which there was telegraphic communication."

Mr. EADY, K.C., for the plaintiff company, said his learned friend was trying to cut down the form of the injunction and in effect to do away with the judgment.

After some discussion, Lord Justice STIRLING suggested words which limited the injunction to competing messages which might be prejudicial to the plaintiff company. This was agreed to.

W. H. Chaplin & Co., Ltd, *v.* The Mayor and Council of the City of Westminster.

This action came on for hearing on Tuesday before Mr. Justice Buckley in the Chancery Division of the High Courts of Justice.

Mr. Henry Terrell, K.C, for the plaintiffs, said his clients were very large wholesale wine and spirit merchants, and the action was brought to restrain the defendants, the Mayor, Aldermen, and Council of the City of Westminster, from erecting an electrical standard on the west side of Villiers Street, Strand, in such a position as to cause an obstruction to the plaintiffs' premises. On November 8th last an action was brought against the Vestry of St. Martin's-in-the-Field and the Charing Cross and Strand Electricity Supply Corporation, but a day or two after notice of motion was served the Vestry of St. Martin's ceased to exist, and the Mayor, Aldermen, and Council of the City of Westminster took its place. That action was therefore dismissed, and the present one raised. Villiers Street was a very narrow thoroughfare, and there was a very steep hill. Half way down the hill, on the west side, was Craven Passage, which was made in 1859 by the South-Eastern Railway Company under their statute. Underneath Craven Passage, and underneath houses on either side of the passage, there were large wine cellars belonging to the plaintiffs. On the east side of Villiers Street there was an Italian restaurant, and the proprietor of that place objected to an electrical standard being placed opposite the shop, on the ground that it prevented him lowering the sun blind. The standard was erected only 4 feet from his window, and owing to his inability to lower the sun blind the goods in the window were injured. The standard was removed, and the local authority then conceived the idea of erecting it opposite the centre of Craven Passage. The plaintiffs protested, because it would cause them serious inconvenience and prevent the loading and unloading of their carts.

Mr. Astbury, K.C., for the defendants, said he denied inconvenience to the plaintiffs. He would contend that this was a public footpath, and that the plaintiffs had no right to pile up cases or leave casks on it.

Mr. Terrell, K.C., proceeding, said he maintained that he had a right to use the pavement for the purpose of loading and unloading his goods. His clients were lessees of the soil to the middle of the roadway, and he had a private right to unload and load carts there for the purposes of his business. His clients suggested to the authorities to erect a bracket instead of a standard, and offered to give them the accommodation for that bracket.

Mr. Astbury, K.C., said the objection to a bracket was that the railway company had power to widen their lines, and that the buildings in the vicinity would have to be pulled down in consequence. The defendants did not want to be at the cost of erecting another post.

Evidence was then called.

Mr. W. H. Chaplin, managing director of the plaintiff company, examined by Mr. Terrell, said the business of the company was a very large wholesale one, and they received delivery at their premises of a large number of casks of various sizes. Frequently there were three vans loading and unloading outside their premises at the same time. If the standard were erected where it was proposed the plaintiffs would be unable to unload pipes and other large casks outside their cellars. It would cause serious inconvenience to their business.

A number of other witnesses were called for the plaintiffs, and all gave evidence as to the inconvenience which would arise if the standard were erected in the position proposed.

Mr. George Green, surveyor for St. Martin's Vestry and afterwards for the City of Westminster Council, was called for the defendants. He said that, in his opinion, there was room on either side of the standard for carts to draw up and unload. He did not consider the standard would in any way cause the plaintiffs inconvenience.

At the conclusion of the evidence for the defence the hearing was adjourned.

On Wednesday, when the case was called, Mr. Justice Buckley gave judgment. He thought it was obvious that to place a post where it was proposed to place the one in question, would affect the elasticity of plaintiffs' proceedings, but the only right the plaintiffs could claim was a right as a member of the public, and they could not assert their individual convenience against the convenience of the public in general. It had not been proved that the defendants were acting unreasonably in placing a post where they proposed to place it. Both in law and in fact, therefore, the plaintiffs failed, and the action must be dismissed with costs.

Kite *v.* New Grand (Clapham Junction), Limited.

This case has been occupying the attention of Mr. Justice Joyce in the Chancery Division several days this week. Plaintiff, who resided at 23, Severus Road, Clapham, asked for an injunction to restrain the defendants, the proprietors of the New Grand Theatre of Varieties, St. John's Hill, Clapham, from so using their engines, which generated the electric light at their establishment, as to be a nuisance to the plaintiff. The defence substantially was that no nuisance was caused. Scientific evidence was called on behalf of the plaintiff to show the amount of vibration that was felt in the plaintiff's house whilst the engines were working. A gas bracket fixed to the wall shook violently, and the windows rattled.

A Lodger at No. 10, Severus Road, also spoke to the windows shaking in his house and articles rattling.

It was arranged between counsel that on Monday two experts, representing respectively the plaintiff and defendants, should visit the plaintiff's house and report to the Court the effect of their experiments. Consequently the further hearing of the case was adjourned.

When the case came up on Wednesday further evidence was given, and an injunction was granted, but its operation was suspended for a month to see the effect of abatement measures which have been adopted.

PARLIAMENTARY COMMITTEES.

London United Tramways.

The Court of Referees, on Friday, had before them the question of whether a *locus standi* should be granted to a number of petitioners against the Bill of the London United Tramways Company. The petitioners objected to were the Southwark and Vauxhall Water Company, the Chelsea Waterworks Company, the Lambeth Waterworks Company, the New River Company, the West Middlesex Water Company, the Grand Junction Waterworks Company, a number of Surbiton ratepayers, the Richmond Electric Light and Power Company, the National Telephone Company, the Middlesex County Council, the Metropolitan Railway, the Metropolitan District Railway, the Great Western Railway, and the London and South-Western Railway Company.

Mr. Baggallay, K.C., who appeared for four of the water companies, supported his claim to be heard before the Committee, which would consider the Bill on the ground that the Waterworks Company stood the chance of having their property injured by certain road alterations, &c., proposed by the Bill, and also by electrolysis. He contended that the modern clauses which were the result of the deliberations of Lord Cross's Joint Committee were not sufficient in this case, and there was a difference in the policy adopted by the two Houses of Parliament. In the House of Lords special clauses with reference to the electrolysis had been inserted, but the House of Commons had refused such clauses to the water companies. Although they had not much experience of the conduit system, yet what experience there was pointed to the necessity of water companies being protected.

Mr. Pember, K.C., supported the claims of the other water companies to be heard in opposition to the Bill.

Mr. Balfour Browne, K.C., who supported the London United Tramways Company, addressed the Court, and argued that ample protection was afforded by the Bill as it stood.

The Chairman said the decision of the Committee was that in reference to interference with mains and widenings the general law gave sufficient protection, but in the Chelsea case they allowed a *locus*. As to electrolytic action, they considered that in the circumstances of the case it should be left to the Committee considering the Bill to say whether the petitions were sufficiently protected, and consequently the Court allowed a *locus* on that point.

A *locus* was refused to a number of inhabitants of Surbiton who claimed that the Urban District Council of Surbiton had not represented the ratepayers by agreeing to the construction of the tramways on the payment of a certain sum of money.

On behalf of the National Telephone Company, Mr. Forbes Lankester asked to be heard with regard to more protection being given to telephone wires crossing the wires or cables of the tramway company. He alluded to the results which occurred in Liverpool a short time ago owing to a heavy fall of snow breaking the telephone wires which came into contact with the tramway wires.

The Court declined to grant a *locus*.

A *locus* to appear generally against the Bill was granted to the Middlesex County Council.

Yorkshire Electric Power Bill.

On Tuesday the Yorkshire Electric Power Bill in its amended form came before a Select Committee of the House of Commons, presided over by Sir William Houldsworth, for the consideration of the clauses. Before the Whitsuntide recess the two rival schemes, viz., the Yorkshire Electric Power and the South Yorkshire Electric Power, came to an agreement by which they virtually amalgamated.

Mr. Frere (Parliamentary agent for the promoters) presented a clause dealing with the question of mains, in which it was provided that the company shall not, without the consent in writing of the local authority, break up any street or allow any electrical line or other works along any street or part of a street in the respective cities of Bradford, Leeds, or Sheffield, which is included within a certain specified area delineated on the plans. He explained that in respect of Leeds and Bradford, the prohibited area constituted a mile radius from the municipal buildings. In the case of Sheffield, the density of population and the situation of the business thoroughfares rendered it impossible to strike an absolute circle of a mile from any given point, and therefore the prohibited area there differed from that of Leeds and Bradford. It was proposed to draw a circle of a mile and a quarter from the Jubilee Obelisk in Pinstone Street, but they had cut off a segment of the circle, and in compensation took a somewhat wider line than otherwise would have been drawn. They had cut off the segment of the circle in a straight line where the circle cut the north side of the River Don to where it cut the west side of the Midland Railway. A copy of the clause and the proposals of the promoters had been submitted to the Corporations affected, but those bodies had declined to take any further part in the discussions before the Committee, reserving their right to oppose in the other House. Mr. Frere explained that the prohibited area at Sheffield would enable the promoters to join up with the Derbyshire and Nottinghamshire

Electric Power Company, without touching the prohibited area of Sheffield.

The Chairman asked if the plans showing the prohibited areas had been submitted to the Board of Trade or Local Government Board.

Mr. Frere said they had not. They would not be sent to those departments until they had passed that Committee.

The Committee after minutely inspecting the plans, decided to pass them, the Chairman remarking that in his opinion they very fairly excluded the populous parts of the cities concerned and gave them a great deal of protection.

In reply to the Chairman, Mr. Frere said that the Barnsley prohibited area was oblong in shape, having been so drawn as to exclude one long street.

The Committee subsequently went through the clauses of the Bill with the Parliamentary agents concerned, and afterwards ordered the measure to be reported to the House of Commons, after which the third reading will take place.

Derbyshire and Nottingham Electric Power Bill.

On Tuesday the Examiner of the House of Lords found that the Standing Orders of the House had been complied with in respect of the Derbyshire and Nottingham Electric Power Bill, and consequently the Bill will go for second reading. The scheme embraces the whole of Notts and Derbyshire, and the proposed capital is £1,800,000, with £600,000 borrowing powers.

City and North-Eastern Suburban Electric Railway.

This Bill came before the Examiner of the House of Lords on Tuesday, on the petition of the promoters to be allowed to insert new clauses. In the Bill it was proposed to authorise the construction of a portion of the railway across Hackney Marshes, and to acquire a certain site on the Marshes for the erection of a generating station, and the petition stated that it was not until after the Bill had been introduced that the petitioners learned that the lands were vested in the London County Council, who objected to their being used for such a purpose. With regard to Hackney Marshes, the new clauses proposed to alter the level of the railway so that it would go beneath the surface; and as regarded the generating station, they had scheduled a new site in the parish of Lower Leyton. The Examiner found that there had been non-compliance with the Standing Orders owing to the lateness of notice, and the matter will come before the Standing Orders Committee of the House, who will decide whether or not the Standing Orders shall be dispensed with, and the clauses added to the Bill.

Underground Railways.

The Joint Committee, which is considering the various underground electric railways proposed in this session of Parliament, resumed its sitting on Tuesday, under the chairmanship of Lord Windsor.

Mr. Erskine Pollock said he had been instructed by the omnibus companies to ask the Committee to be allowed to offer evidence as to the passengers carried by the 'buses over the route proposed by the different railways.

The Chairman said that any facts as to the omnibus passengers would be useful.

Mr. Balfour Browne, K.C., said that of course the omnibus companies had no *locus* before the Committee, but he could not object to mere evidence.

Counsel applied to the Committee that evidence from the National Association for the Extension of Workmen's Trains might be heard, and it was agreed that Alderman Dew, L.C.C, should be heard.

Mr. H. C. Palmer, traffic superintendent of the Metropolitan Railway Company, was called in opposition to various schemes, and described the routes of the railway, which included the Inner Circle, and went to Hammersmith, Kew, Richmond and Aylesbury. The Metropolitan Railway were in a unique position with regard to cheap fares. They had close upon 4,000 different fares, varying from 1d. to 2d., and a large proportion of these were 1d. fares. In 1900 they carried 29,000,000 passengers at 1d., over 13,000,000 at 1½d., and over 8,000,000 at 2d. a journey. They ran over 100 workmen's trains. They had considered the proposal of the Central London Railway to form a loop at each end of their system, and though the advantages of such loops were more imaginary than real, the loops would occupy a valuable area and prevent any other line coming in on the same level, and it would prevent other lines joining up on the same level. He saw no reason why the Central London Railway should not largely increase their carrying capacity without the loops. They might extend one line the length of a train, which would enable them to deal with five trains at each terminus. They might first increase the number of their coaches to each train. They now had six coach trains, and he saw no reason why they should not have eight coach trains. At the present time the City was well served by the existing railways, and he did not think the Central London Railway should be extended to Liverpool Street. To centralise the whole of London's railways at one point would cause confusion, and would not solve the problem of further travelling facilities. He was familiar with the proposals of the North-East London Company, which proposed to run to Tottenham and Walthamstow. That scheme commended itself to him so far as it dealt with Liverpool Street, but he objected to that portion from Liverpool Street to the Monument, as he thought there was no necessity for it. He thought it better that tube railways should be short lines working between populous centres rather than there should be long lines running through populous centres. With regard to the proposals of the Islington and Euston Railway, which was an extension of the City and South London Railway Company, he considered it was not a good route, and it really was a parallel line with the Metropolitan Railway. It would serve a larger public interest if the line extended north-westwards. As to the West and South London Junction Railway, which started from Paddington and went to Victoria and the Oval, he contended there was no need for the new line between Paddington and Victoria, and believed the traffic would not justify the expense of constructing the line.

The Chairman pointed out that if there was no traffic the promoters would not get the money to construct them.

Mr. Balfour Browne: And consequently they will not compete with the Metropolitan Railway.

Continuing, Witness said that when they had electric traction on the Metropolitan Railway they would be able to run a quicker service of trains. The southern portion of the scheme of the West and South London Junction Railway was already covered by the authorised scheme of the Baker Street and Waterloo Railway.

Cross-examined by Mr. Balfour Browne, Witness said he was not aware that the engineers of the tube railways had provided for openings in the tunnels to deal with breakdowns.

By Lord R. Cecil: The Paris underground railway was successfully worked. They had at present only four coach trains, but intended to increase the number of coaches. The Paris railway had a loop only at one end.

In reply to the Chairman, Witness said that the question of the train service on the Metropolitan Railway with the adoption of electric traction was now occupying the attention of the directors. He thought that if electric traction was adopted for one part of the railway only it would be only half doing the thing, and that means would be found of hauling all the trains which came through the tunnel by electric traction. The service of trains could be considerably increased.

Mr. Thomas then addressed the Committee on behalf of the Metropolitan Railway in opposition to the schemes on which he had examined Mr. Palmer. He pointed out that the schemes in question gave no opportunity for working men getting outside London to live, and submitted that when electric traction was substituted for steam on the Metropolitan Railway, that line would be able to meet all the necessities of the public in respect of the places touched by the railways which be opposed.

Mr. Alderman Dew, L.C.C., the secretary of the National Association for the Extension of Workmen's Trains, gave evidence, and stated that many of the proposed railways would give little additional facilities to people wishing to get outside London to live. He supported the schemes for carrying tube railways to Walthamstow and Tottenham, but thought they should be carried out to a greater distance. In the case of the Hammersmith line, he also thought it should be carried further out. He considered clauses should be inserted in the Bill for cheap workmen's trains.

The Committee considered their further procedure, and decided to confine the evidence at present to the question of route. Later on evidence would be heard on all questions touching vibration, subsidence and construction.

The Committee adjourned.

NOTE ON NICKEL AT HIGH TEMPERATURES.

By ALBERT CAMPBELL, B.A.

Some time ago Dr. Fleming discovered that the conductivity of pure modern nickel is very much lower than that of the purest obtainable some years past. As this point seems to be disputed by Van Aubel, I think it may be of interest if I give the results of some experiments which I have made in connection with my hot wire current regulator. Two

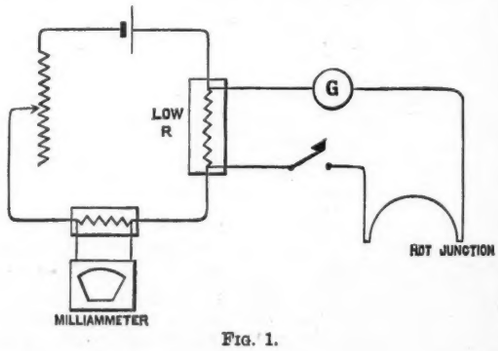


Fig. 1.

specimens of nickel (A and B) were tested; both of them were commercial products, (A) being procured in Germany this year, while (B) was bought in this country five or six years ago. Their resistivities at 0° C. were found to be approximately 8 and 12 microhm-cms. respectively. That of the old specimen is very near Matthiessen's value (12·3), while it is interesting to notice that (A), although only commercially pure, is very much nearer Dr. Fleming's value (6·9).

In order to find how they behaved at different temperatures, a length of each of the wires was wound on mica, and thicker nickel leads were soldered with gold to the ends.

The coils were wrapped in asbestos along with compensating leads, and a Platinum-rhodium-Platinum junction, which was calibrated in sulphur vapour and steam. The

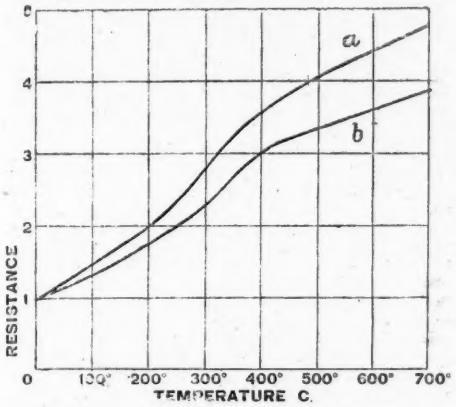


FIG. 2.—(*a*) NEW NICKEL. (*b*) OLD NICKEL.

voltage of the thermo-couple at the various temperatures was measured as in fig. 1 by balancing it against the P.D. produced in a low resistance by a current which was measured by a Weston milliammeter. This simple method is that used in the German Reichsanstalt. The heating was done electrically by means of a coil of ferro-nickel, wound non-inductively round the outer wrapping of the coils.

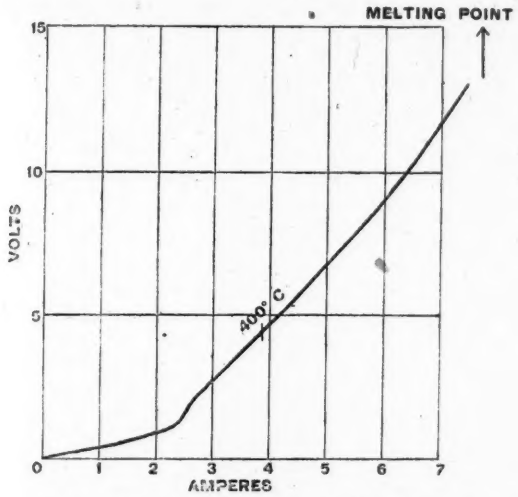


FIG. 3.—CHARACTERISTIC CURVE OF NICKEL WIRE.
Diameter 0·3 m . (12 mils.)

In fig. 2 are given the temperature-resistance curves obtained, and it will be noticed that both of them have the well-known bend about 300° C. The older and presumably less pure specimen has less variation with temperature than the other, of which the mean temperature-coefficient is slightly over 0·5 per cent. per degree from 0 to 200° C. In the light of these curves it is interesting to examine fig. 3, which shows the "characteristic curve" (*c*, *v*) for a wire of sample (A) carried gradually up to its melting point by a current (*c*) passed through it. It will be seen that, after the bend is passed, a very long part of the curve is nearly straight, and that up to very near the melting point there is no abrupt change.

In conclusion, I may mention that, in combination with iron, the older specimen (B) has slightly smaller thermo-electric power at ordinary temperatures than (A) has.

CORRESPONDENCE.

Motors on Single-Phase Systems.

The benefits of a motor load have been so frequently insisted on, that there is a danger of its being obtained at too great a sacrifice. It may increase the output of the station and reduce the cost per unit generated without in any way adding to the profits of the undertaking. Where motors can be supplied from a direct current network without any further expense, the business is worth getting, but, even in this most favourable case, it must be remembered in deciding the price which should be charged:

1. That the motor load will, at some period of the year, overlap the lighting peak, and hence require extra plant, buildings, mains and wages.

2. That longer hours of running mean more repairs, a more rapid depreciation of plant, and, in addition to extra coal, a certain amount of extra wages.

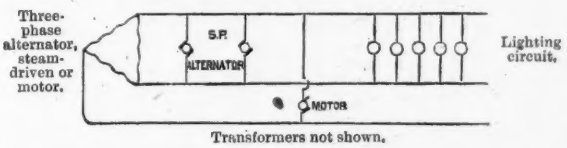
In order to compete with gas at 3s. 3d., my own experience is that the price of current for motive power should not exceed 2d. per unit, and, even at this rate, a careful analysis will show that in several of the largest direct current stations the margin of profit is very small.

In single-phase alternating stations the outlook is still less favourable. When the motors are run directly on the lighting network the above objections still apply with the further ones that:

1. The price of current to compare favourably with direct current and gas must be still further reduced to compensate for (*a*) the lower efficiency of alternating current motors; (*b*) their low p. f. (if the charge is based on the demand) unless expensive condensers be used; (*c*) for the extra cost of continuous running necessitated by the difficulties of starting.

2. The heavy starting current and consequent reactive drop on the transformer makes good regulation at consumers' terminals, and in a small station at the generator terminals, very difficult.

3. With generators possessing a very bad wave form it is sometimes impossible to get the motors to run at all or only with excessively poor torque, unless there is a large non-inductive load upon the generators.



Transformers not shown.

When all these facts are taken into account it would be of interest to know whether the motor supply of single-phase stations working under average conditions is really being run at a profit, or whether the lighting consumer is paying for the loss.

It was recently suggested in your columns to use a M.G. and battery for the purpose of supplying power users. Now the M.G. and battery is of the greatest use in a variety of ways in alternating current stations, such as exciting or supplying the day load on Sunday and other times of light load, but as a means of supplying power to the outside, except in the smallest quantities, it is not financially successful. The average watt-hour efficiency of a battery spread over several years cannot be taken as more than 70 per cent., while 75 per cent. is about the all-day efficiency of the M.G. To this must be added the losses in distribution, so that less than 50 per cent. of the current generated gets paid for. Hence, again assuming 2d. a unit as the price, the total cost of generation must not exceed 1d., including the extra wages, repairs, depreciation and interest upon the M.G. and battery

and direct-current mains, in addition to the share of similar charges upon the main generating plant, and with the cost of generation which is found in the average central station, it will be found that the margin for profit is very small.

As a matter of fact, the business is hardly worth having excepting in those cases where, for special reasons, a higher price can be obtained or an exceptionally large and steady motor load can be had. An interesting solution of this problem, of which I have recently met with several examples in the States, consists in supplying a third or power wire from a three-phase generator, one of whose windings is connected across the single-phase bus bars, the system bearing some resemblance to a mono-cyclic one. The lighting branch, which usually proves the greater part of the load, is, under ordinary conditions, unaffected by the operation of the motors. While the motor load is small it is possible to dispense with a steam engine, using the three-phase generator as a motor simply, and by this means a fairly constant supply is given in many American plants which have only one steam-driven three-phase generator. The three-phase machine may be star or triangle wound.

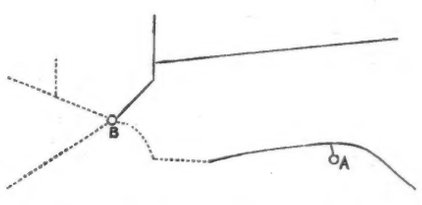
T. H. Minshall.

Electricity Works, Croydon.

Information Wanted.

Could you, or any of your readers, kindly give me the following information :—

A central station is situated at A, as in the diagram below. It is required to supply electricity from it to a tramway company at the point B, a distance of two miles, and also at intermediate points between A and B. What objection (if



any) would there be to transmitting the current from A to B by the three-wire system, supplying the portions of the tramway indicated by dotted lines from one outer, and those shown by the continuous lines from the other, the rails being used as the middle conductor? The principal traffic would be within a $1\frac{3}{4}$ miles radius from B. In such a system should there be any difficulty in balancing?

Silex.

Localisation of High-Resistance Breaks.

With reference to the article by Mr. J. Rymer Jones, on "Localisation of High-Resistance Breaks," Mr. Jones appears to be unaware that the method he describes is practically the same as the method given by me on page 308 of the second (1881) edition of my "Handbook of Electrical Testing," and in all subsequent editions (page 504, sixth edition). Mr. Jones has doubtless elaborated the method in a very practical manner, and has thereby increased its utility; and putting the formula, as he has, in the form of tables is doubtless an advantage. Mr. Jones claims that the method is very suitable for the localisation of *high-resistance* breaks; he says on page 961, "The higher the fault resistance the greater the charge in the cable, because the potentials in the cable portion of the circuit are higher. Moreover, the higher the fault resistance the more cells may be used to increase the charge. It will, therefore, be seen that a high resistance tends to increase the efficiency of the localisation, which depends on the charge being large enough to be accurately measured."

Mr. Jones has, I think, fallen into error in making this statement; the bare assertion is doubtless correct, but the premises are not. There are in the test, two important factors which both require to be accurately known, viz., the resistance R l (figs. 1 and 2), and the charge T A B t; but although it is true that the higher R l the greater is T A B t, yet Mr. Jones appears to overlook the important fact that when R l is very high, then any variation in its value but very slightly varies T A B t, or what amounts to the same thing, a very small error in measuring the value of T A B t, makes a very large error in the determination of the proportion which A B is of R l.

Thus, for example, the value of T A B t would be but little larger ($\frac{1}{2}$ per cent. only) if the resistance of the fault were 100 times that of the cable, than it would be if it were only 10 times that of the cable, so that in both cases the accuracy with which T A B t could be measured would be practically the same. But when we come to calculate the value of A B either by a formula or by means of tables (which, of course, are only formulæ put in tabular form), then it will be found that, say, a 1 per cent. error in the value of T A B t will make a much greater error in the worked out value of A B when the resistance of the fault is 100 times that of A B than when it is only 10 times, and if the fault has a still greater resistance, then the error in the value of A B will be greater still.

We, in fact, gain something from the fact of T A B t being large, but we lose very much more from the proportion of the fault resistance to the cable resistance being large.

It is an axiom in every form of test that unless a certain proportion exists between the various elements of the test, then accuracy cannot be ensured. If we depart from this proportion then what we gain in one way we more than lose in another, and this applies to the test Mr. Jones describes, just as much as it does to other tests. I brought this fact very prominently forward in my "Handbook of Electrical Testing," but in the particular case of the test which is similar to that of Mr. Jones, I did not deal with the "*Best conditions for making the test*," though there would be no great difficulty in doing so.

H. R. Kempe.

Engineer-in-Chief's Office,
General Post Office.

The British Press and British Industry.

In reply to your correspondent "E. J. F." in your issue of the 31st ult., replying to my letter of the 24th ult., and after taking into consideration the many side issues that may arise through this controversy, I have decided not to enter into a lengthy correspondence on this subject, and to reply to every correspondent who thinks I am wrong: My impressions are my own; they might be right or they might be wrong. I constantly study the British Press, and know the kind of men they are who control some of the most influential journals in the provinces; and I also know the manners and methods of British engineers—mechanical and electrical. The point in dispute is not the character and quality of the work turned out by our manufacturing firms, but the time in which the work is done and the way in which orders are tendered for. This subject finds, curiously enough, a singular flood of light thrown upon it in the controversy between Sir Alfred Hickman, M.P., and Lord George Hamilton. The case of the latter, if I understand him rightly, is this: American firms are not superior to the British in the character and quality of the work turned out, but they are more disposed—more anxious—to try and please their customers. Once having found out what the customer wants, they are positively keen to submit new and improved designs, calculated to reduce time and labour, at cheaper prices. To no Englishman does cheaper price in itself make any appeal; but when lower figures are accompanied by a very obvious desire to serve the customers in other directions by improved machinery, the said customers must be pardoned if they do give the American contracts better consideration.

It is all a matter of business. My opinion, rightly or wrongly, is that our manufacturers are too stiff; they decline to look at what is coming to-morrow as well as what is on for to-day. The British Press understand this attitude far better than some of us think, and in trying to show us technical people the error of our ways, they are, I maintain, doing a real and substantial service.

T. W. Sheffield.

Manchester, *June 11th*, 1901.

BUSINESS NOTES.

Bankruptcy Proceedings.—The case of A. W. B. Pearson, electrical contractor, 81 and 82, Palmerston Buildings, E.C., came before Mr. Registrar Brougham, at the London Bankruptcy Court on the 7th inst. in relation to the public examination of the debtor. Mr. C. A. Pope, Assistant Receiver, reported that since the proceedings had been instituted the debtor had committed suicide, and his Honour ordered the examination to be adjourned *sine die*. No statement of affairs has been lodged, but when the debtor attended upon the Official Receiver for his preliminary examination, he roughly estimated his liabilities and assets at £16,000 and £6,000 respectively. He then stated that he commenced the business of an electrical contractor in 1898, under the style of Pearson & Co. He entered into contracts with the London County Council and other public bodies, and had also been interested in various patents and secret processes. Among the number were Eborine (a vulcanite substitute), a rotary engine pump, a patent switch, an artificial india-rubber, a method of treating waste cork, &c., for the manufacture of flooring, paving, &c., and a dry cell. He had been concerned in accommodation bill transactions with certain firms, who are also in the Court, and whose acceptances he discounted at 1 per cent. generally above the Bank rate. To the failure of those and other firms to meet their acceptances at maturity the debtor attributed his insolvency.

The first meeting of creditors was held last Tuesday at the London Bankruptcy Court of Alfred Mavor, electrical engineer, and a member of the Whitehall Club. The debtor states that from 1889 to 1896 he acted as the general manager of the Fowler-Waring Cable Company, and in the latter year he took up the position of managing director of a company at Northfleet at a remuneration of £1,200 a year. The company went into liquidation in 1898, and its property was purchased by the late Lord Wantage, who employed him as superintending engineer at a salary of £750 per annum. That arrangement continued for about a year, when the works were shut down by Lord Wantage, who gave him an option to purchase them. Since that time he has been solely engaged in endeavouring to form a company to take over his interest in those branches of the electrical trade and industry in which he has been trained and occupied. The debtor adds that he has acquired certain options over patents for electrical cables and accumulators. He has no other assets, and the liabilities roughly amount to £2,500. In the absence of any offer, the case was left in the hands of the Official Receiver to be wound up in the ordinary course of bankruptcy.

Dissolution.—Messrs. F. B. Nicholson and W. H. de Winton have dissolved partnership as and from March 30th, 1901. Mr. Nicholson will continue to carry on the business under the style of Nicholson & Co., at 53, Victoria Street, as heretofore, and will attend to debts. Mr. W. H. de Winton will carry on business on his own account at 53, Victoria Street, Westminster.

Book Received.—"The Induction Motor," by B. A. Behrend. New York: *Electrical World and Engineer*. $1.50.

Catalogues and Lists.—Messrs. Mavor & Coulson, Limited, of Glasgow, have brought out a new issue of their illustrated catalogue. Every care has been taken to obtain the best results of the illustrator's art for showing their generators as they appear coupled to different types of engines for supply to Birkenhead, Blackburn, Glasgow, and various other Corporation electrical undertakings. Dimensions, sketches, and information in tabulated form are given relating to bipolar, multipolar C.C. dynamos manufactured by them; a series of pictures show some of the applications of electric motors for driving pumps, &c.; details of C.C. multipolar open and enclosed type motors; switchboards, motor-starting and other switches; portable drills and deck planers; projectors, coal cutters (Hurd's), and the firm's "C.C." concentric wiring system and fittings therefor; all of these are placed before the trade in a very presentable form, with handy thumb index.

The B.T.H. Company's pamphlet, No. 96, is a full and illustrated list of their rheostats for generators and motors. No. 97 describes electrically-driven ventilating fans and blowers.

The Hoshor-Platt Company, of New York, have sent us a catalogue, in which locomotive coaling stations, as arranged with J. C. Hoshor's noiseless gravity bucket conveyor, are explained by letterpress and a number of outline drawings.

The International Electric Company is issuing monthly leaflets, bringing its latest improvements before the notice of the trade. The "plane" all-china H.V. switch, the water-tight telephone connecting box for traction work, and other things, are shown in the first of these lists.

Messrs. Hedges, McKrell & Co., Limited, of Barbican, have issued a net trade list of their electric lighting fittings and accessories.

Messrs. Julius Sax & Co., Limited, send us a trade list of their high voltage electric lighting accessories. Most of the articles shown therein are registered designs.

Copper Sulphate.—We have received samples of this useful substance from the Birmingham Copper Sulphate Company, who inform us that they manufacture "copper sulphate of absolute purity (100 per cent. and over)." We do not quite understand how the degree of purity can exceed 100 per cent., but the specimens appear to be clean and of good quality.

Fire.—About midnight on Thursday last week a fire broke out in the electric accumulator works of Messrs. Rooper and Co., Backwalls, South Stafford. It originated, it seems, in the room where the electric batteries are charged, and the building was soon alight. The Stafford Fire Brigade were early on the spot and played upon the flames, but their efforts were hindered by the fumes emitted from the acid. They managed, however, to cut through the roof, and so kept the fire from another room where there was a quantity of sulphuric acid stored. Damage to the extent of between £500 and £550 was done.

Installation Work in the Eastern Counties.—The installation of the electric light into Norfolk County Asylum at Thorpe has been entrusted to Messrs. G. N. C. Mann & Co., of Norwich and Lowestoft, the cost being nearly £4,000. The same firm also has in hand the electric lighting of Suffolk County Asylum near Ipswich, the new Technical Institute, Norwich, &c., as well as complete installations for the electric lighting and water supply of some half-dozen country mansions in the Eastern Counties, comprising engines of various sizes and types from 5 up to 20 H.P.

Schmidt Superheating.—Schmidt's Superheating Company, Limited, of Broad Sanctuary, S.W., have just received advices from their German office that one of the principal Italian railway company's has ordered a locomotive engine working with superheated steam under the Schmidt patents with a view to the adoption of the system on their lines. The Schmidt Company's joint general manager, Mr. T. Perceval Wilson, who for a considerable number of years was chairman and managing director of the firm's predecessors in business, Messrs. Easton, Anderson and Goolden, Limited, is now in America in connection with the disposal of the Schmidt patents for that country and for Canada.

Messrs. Easton & Co., Limited, have received from the British Xylonite Company, Limited, for delivery at their Brantham works, near Manningtree, Essex, for two 300-I.H.P. horizontal tandem compound condensing engines, to run at 140 revolutions, in conjunction with a Schmidt patent direct-fired superheater, which will superheat the steam for the engines to 700° F. The engines will also be fitted with the Schmidt patent receiver superheater, and the guaranteed steam consumption is 10 lbs. per I.H.P.-hour.

Smoke.—At the Manchester City Police Court the Clayton Engineering and Electric Construction Company, Limited, Crabtree Lane, has been fined 60s. and costs for committing a black smoke nuisance.

Trade Announcement.—Mr. Ernest Roberts, electrical engineer, &c., notifies that owing to extension of business he recently moved into larger premises at 6, Holborn Place, W.C.

ELECTRIC LIGHT AND POWER NOTES.

Beckenham.—At a meeting of the U.D.C. on Monday last it was reported that a letter had been received from the British Insulated Wire Company, agreeing to charge 2d. per unit for energy supplied to motors, with a reduction to 1½d. per unit where so used on an average for six hours a day. The company also agreed to reduce the charge for energy to the Technical Institute and Public Baths to 4½d. per unit. The Council decided to approve these terms.

On Wednesday last week a L.G.B. inquiry was held at the D.C. offices, Beckenham, respecting an application from the Council for leave to borrow £20,000 for the purpose of extending their electric lighting machinery and cables. Mr. R. P. Wilson, the Council's electrical engineer, gave evidence with regard to the proposed extension, which had been rendered necessary by the increasing demand for the light. There was no opposition.

Birkenhead.—At the monthly meeting of the T.C. last week on electrical matters, a scheme of the Watch Committee was confirmed to substitute arc lamps for gas in certain main streets. This will require 42 arc lamps, at a capital expenditure of £1,844. The annual cost of lighting by the new lamps will be £891, as against £713 at present.

Bradford.—The Corporation has agreed to allow Messrs. Bennis & Co., Limited, of Bolton, to fix one of their mechanical stokers to a boiler at the electricity works, by way of experiment in regard to the prevention of smoke and economy of working.

Cardiff.—In view of the contemplated change of the supply system to direct current, Mr. Ellis has reported to the Lighting Committee in favour of a revised scale of charges, which is under consideration.

Crewe.—The T.C. is to apply for a £5,000 loan for electric lighting purposes. To the end of March £27,056 had been expended, and after adding other liabilities incurred there was £4,364 to be provided above the £35,970 already sanctioned. It is stated that so far there has been a profit of £25 on the working.

Dublin.—The application of the Corporation to the Board of Works has elicited a reply stating that before the loan of £254,500 can be considered, it will be necessary for the Corporation to clear up the instalments due on former loans, which have been allowed to accumulate. At the same time, it is not thought likely

that the Board of Works will really refuse to grant the required loan.

At a recent meeting of the E.L. Committee 59 tenders for No. 5 and No. 6 Sections of the contract for lighting the city were received and opened. The work will be done well within the estimate for these sections.

Dundee.—The city electrical engineer, Mr. Tittensor, has recommended the experimental adoption of the Smokeless Chimney Company's system at the electricity works.

East London, Cape Colony.—The Corporation is advertising for an electrical engineer, salary £200 per annum.

Elland.—The D.C. is about to proceed with the prov. order obtained two years ago, and is considering a £10,000 scheme.

France.—The electric power installation at the works of the Société des Acieries de la Marine et des Chemins de Fer, at Boucou, France, has lately been considerably extended. M. Henrion, of Nancy, has put down two 150-KW. steam dynamos. The works are lighted throughout by electricity, and the bulk of the machine tools are electrically driven.

Halifax.—The Electricity Committee has decided to supply motors to local business men at a yearly rental of 10 per cent. on the capital cost, and to supply energy at the pricetof 2d. per unit.

Hampton Wick.—In reply to the U.D.C., the London United Tramways, Limited, state that they are not in a position to go into details as to the supply of current for electric lighting as originally proposed by the company, and the matter has been adjourned pending further information.

Hoylake.—Mr. H. P. Boulnois, L.G.B. inspector, held an inquiry at Hoylake on Thursday of last week, respecting an application made by the Hoylake and West Kirby U.D.C., for power to borrow £13,500 for the extension of the electric lighting works and cables in the district. It was stated that the Council had just completed the works and cables as originally designed, in respect of which the L.G.B. had sanctioned an expenditure of £27,000. Applications had been received for over 6,000 lamps of 8 C.P., which very nearly came up to the total available supply. The final cost, if the Council carried out the works as intended, would be about £40,500. By the additional expenditure the capacity would be increased from 7,000 to 14,000 8-C.P. lamps, and it was anticipated that during the winter 10,000 more connections would be made. Mr. T. L. Miller, consulting electrical engineer to the Council, described the existing machinery and the plan of the mains, and Mr. T. Foster, district surveyor, gave particulars of the new buildings.

On Saturday afternoon last the new electric generating station, equipped by the Urban District Council, was formally opened. The chairman and members of the Council, and a number of residents who had been invited to witness the opening, assembled in the generating house, and after an informal inspection of the machinery, Mr. Miller gave a description of the machinery and of the method of working. He said that they had, up to the present, a very fair demand for energy. He asked the chairman of the Council to declare the undertaking open and to accept a small case containing a key, which he handed to him, as a memento of the event. Mr. George Wall, chairman of the Urban District Council, said he had great pleasure in accepting a memento of that interesting ceremony. He had to confess that when the lighting scheme was broached, he, and many others, thought it was somewhat previous for the district, and that it was too early to do such a work. Some of them thought otherwise, so they were there that day with those magnificent works. With the applications they had had already, it would be a paying concern from the first. They did not guarantee that, but they hoped it would be, and that it would be a very great boon to the rates and to the district. The chairman then proceeded to set the machinery in motion. The company were then conducted through the different parts of the building by Mr. Miller and Mr. Ernest Marples, the manager and engineer of the station. After the inspection, the chairman of the Urban District Council entertained the members of the Council and a number of friends to luncheon at the Royal Hotel, Hoylake. The Chairman, in responding to a toast, said that, as a self-governing body, they were just then about 10 years old. They had grown almost out of nothing, and he would not weary them with the figures he could give them as to the new roads and streets which had been built during the last 10 years, but the Council knew; in the last 10 years the district had increased in rateable value from £25,000 to £65,000. It was clearly the duty of the governing body of such a district to develop its resources to the fullest extent. Such a district must grow, and if the development were not on proper lines, the result would only be confusion. They had provided broad streets, promenades, and a marine lake during the last 10 years. Now they had embarked on a new enterprise, and had risked the ratepayers' money on the new undertaking. They found that other authorities were providing the new light, and that it had been satisfactory, and they found that they must move with the times. They had moved with the times, and had started with a modest plant, and they found that before opening they had almost as many consumers as their modest plant could supply, and they had had to make arrangements to meet the wants of consumers. They started with an installation capable of supplying 7,000 lamps, and had got consumers to the extent of 6,000 lamps already, with which the undertaking should about pay its way; but without much additional expense they were increasing the installation to 14,000, and they hoped by next winter to have 10,000 lamps connected, and with such figures they would be in a position to pay their way. It was rather soon to say what they were going to do with the profits, but they hoped the profits would be a relief to the general body of the ratepayers. They must not only think of those profits in the rate books, but that visitors would go elsewhere if greater inducements were offered to them. In the opinion of the Council, the provision of the light was doing much for the district. Various other toasts followed.

We shall give some notes of the plant next week.

Kingstown.—The U.D.C. has adopted a proposal that the L.G.B. should be asked to sanction a loan of £50,000 for the purpose of electric lighting.

Leigh.—The Tramways and Electricity Committee has decided that from March 31st last electricity supplied for power purposes be charged for at the rate of 3d. per B. of T. unit for the first hour's use of the maximum demand, and beyond that quantity ⅔d. per unit.

Liverpool.—At the inquiry *re* loan last week it was stated to the inspector, Mr. H. P. Boulnois, that the electrical energy produced by the old company in 1895 was 1,352,511 units; last year, under the Corporation, 11½ million units were produced, and the estimate for the present year was 20 millions. Consumers had increased from 1,300 to 3,450, and lamps had largely increased in number, while the price charged had been greatly reduced. The £300,000, for the borrowing of which powers were sought, was needed for developments during the next twelve months.

New Malden.—The U.D.C. has decided to approach the local authorities at Kingston and Wimbledon for terms as to a supply of electricity for street lighting, the proposals made by Mr. Warden-Stevens on behalf of a company having been declined.

Newcastle-upon-Tyne.—In an interesting report on the supply of electricity in the city, Mr. Mordey recommends that the purchase of the existing systems be proceeded with at once, as, owing to the multiplicity of systems in progress or in operation, there will be great difficulty in doing so at a later date.

Newport.—The balance-sheet issued by the E.L. Committee shows that the gross profit upon the electric light supply last year was £2,557, but the interest and repayment of sinking fund amounts to £5,322, so that there is a deficiency to be met out of the rates of £2,765, against a net profit of £403 in the previous year. The deficit is mainly due to an increase in the coal bill by £1,774, due to high prices at which contracts were let, the increase in the coal consumption only being 160 tons. In addition, there is an increase in the interest and sinking fund account for the year of £1,663 due to the large repayments for new machinery.

North Metropolitan District (East Middlesex).—The District Councils of Tottenham, Edmonton, Wood Green, Southgate, and Enfield, whose joint scheme for the promotion of an electricity Bill recently fell through, now propose to hold a conference to consider the new position of affairs. It is probable that each district will go for a prov. order.

Northwich.—On Thursday last the new bridge over the Weaver, at Winnington, worked by electric power, was successfully operated for the first time. The bridge was designed by and built under the supervision of Mr. Saner, engineer to the river Weaver Navigation; it gives access to the loading wharf of Messrs. Brunner, Mond & Co., chemical manufacturers. The bridge is 90 ft. long, 10 ft. wide, weighs 50 tons, and is worked by a 6½-H.P. motor. The trials were in every way satisfactory.

Portsmouth.—At an inquiry held on Friday last by Mr. R. H. Bicknall, M.I.C.E., L.G.B. inspector, into an application for a loan of £32,000 for new boilers, new boiler house, feeders and necessary small extensions, over a period of 12 months, it was stated that in March last the equivalent of private supply was 87,528 8-C.P. lamps, and there were 264 arc lamps for public lighting. The total possible output is now 1,836 KW., including a spare set of 500 KW. During last winter the maximum demand was 1,506 KW.

Romford.—On the proposal of Mr. Fletcher, the question of utilising the powers conferred upon the Council by the provisional electric lighting order was referred to the Parliamentary Committee for consideration and report.

St. Helens.—According to the balance-sheet of the electrical department for the past year, a profit of £1,220 was shown. After wiping off £666, deficit from the previous year, a net profit for the two years of £554 was shown, which will be carried to the reserve fund. The Electricity Committee have resolved to apply for permission to borrow £10,000 for additional plant for traction purposes, and £16,500 for lighting.

Salford.—The T.C. has decided to replace the maximum demand system of charging by a uniform rate of 4½d. per unit for lighting and 2d. for power.

Sheffield.—The accounts of the electric supply department show a net profit of £4,048. The accounts of this department cover a period of 15 months. During that period the total expenditure was £92,609 7s. 3d. (the main items being £21,767 for plant and machinery, and £52,815 for mains and services). The total income was £41,939, being an increase of £18,597 over the year 1899

Comparing the gross profits with 1899, the sum is £11,632 more, which is encouraging, as the average price per unit for 1900 and 1901 is only 3·30d., as against 3·98d. in 1899. It is doubtful if such satisfactory results will be obtained next year, because of the probable unproductive expenditure of capital during the change-over of the system to 50 periods.

The E.L. Committee recommends that the salary of Mr. S. E. Fedden, the general manager of the electricity department, should be increased from £500 to £600 per annum.

Shrewsbury.—The T.C. has decided to make application to the L.G.B. for sanction to raise a loan of £16,526 for additional cables, works and machinery for the extension of the electric light undertaking.

South Shields.—The applications for the electrical engineership were reduced by the Committee to five, who were to appear before a meeting on Tuesday.

Teignmouth.—The electric lighting prov. order will be allowed to lapse by the U.D.C.

Hungary.—It has been decided by the Hungarian State Railway authorities that all the principal railway stations in Buda-Pesth shall be lighted by electricity. The first installations will be made at Franzstadt and West stations, and at the Danube goods station.

Waterford.—The County Borough has retained Messrs. Lacey, Clirehugh & Sillar to furnish a report on electric lighting.

Winsford.—The B. of T. has informed the U.D.C. that it has no power to grant an extension of time, and of its intention at the expiration of the lighting order to consider the question of its revocation.

Wolverhampton.—The annual report of the E.L. Committee shows that the total expenditure on the undertaking up to March 31st last is £92,280. Of this the chief items are—buildings, £13,533; machinery, £22,030; mains and cost of laying, £22,029; meters and electrical instruments, £6,915. The total capital expenditure during the financial year just ended was £18,217. The sale of energy has realised a total of £9,953, and public lighting (street arc lamps) £1,275. These, together with other items, brought the total income up to £11,471. The revenue account for the year shows a loss of £131, partly due to an expenditure of £546 out of the revenue on the "change-over," partly to the reduction of the price per unit. The number of lamps connected increased by 34·4 per cent., and the units sold by 31 per cent. during the year.

Woolwich.—The Borough Council has given notice of its intended purchase of part of the undertaking of the Blackheath and Greenwich Electric Light Company.

ELECTRIC TRACTION NOTES.

Birkenhead.—A recommendation from the Electrical Tramways Committee that double tracks should be provided instead of single tracks in specified streets, and that sanction should be obtained from the B. of T. to borrow £13,000 for 15 additional cars; £7,500 for extra generating plant, and £1,000 for machinery and fittings for the north-end depôt, was adopted by the Council.

Bootle.—The first annual report of Mr. W. R. Wright, borough electrical engineer, for the year ending March 31st, shows that in regard to public lighting, there were 36 lights erected when the works were taken over, and since that period 107 arc lamps had been added, an increase of 71. There was also an increase of 490 in the incandescents used for public lighting, and 3,750 for private lighting. The last figures were not thought to be entirely satisfactory. That people, however, were gaining confidence in the department was shown by the number of recent applications. Referring to the tramways, it was pointed out that there were 55 cars in use, the units consumed being approximately 2,000 per day. In consequence of the constant breaking down of the insulation of the mains, arrangements have been made with the contractors to subject the whole of the mains, as laid by them, to a test by applying a pressure of 1,000 volts between all mains and earth, and so breaking down all weak places. Although there was an estimated deficit of £1,800, the result was full of encouragement. The plant put down had been capable of dealing with a large tramway load, but only had a small load up to October last. Liverpool expected to take some 700,000 units per annum. So far this year they had taken about 395,000, or about half, so that the plant had been practically idle for the half year. The coal bill seemed heavy, but it must be remembered that the borough was buying in a very expensive market. The contract expired in June. The contract ought to be reduced by about one-third, making the cost 6d. instead of 9d. per unit. This would be further reduced by the extended tramways load and public lighting requirements.

Bradford.—The City Council on Tuesday discussed at some length a proposition of the Tramways Committee, "That the Demerbe type of rail be used in all forthcoming tramway work, excepting the reconstruction of the Manchester Road line, as to which it is already arranged that girder rails shall be used." A number of members objected to the resolution as binding the Corporation to the use of the Demerbe rail for all time to come, and the chairman of the Committee agreed to an amendment making his proposition apply only to tramways now contemplated. In that form it was carried. A very large and rapid extension of electric tramways is contemplated.

Canary Islands.—The *Board of Trade Journal* says that H.M. Consul for the Canary Islands reports that the electric railway from Santa Cruz to Laguna, which has been in course of construction during 1900, is now completed and has commenced working. The railway will doubtless prove a great boon to the inhabitants of both towns. The idea is to carry it on to Orotava, the well-known health resort on the north side of the island, thus bringing the three towns within easy reach of each other. The railway has been built by a Belgian syndicate, who obtained a concession from the Spanish Government for 60 years. The capital involved in the scheme is about £64,000. Most of the material has been imported from Belgium and Italy. (*Foreign Office, Annual Series*, 2,605.)

Cardiff.—Certain roads which run under railway arches will have to be lowered if double-decker cars are employed, as the B. of T. requires a distance of 6 ft. 6 in. between the roof and the bridge. When the question came before the T.C. on Monday, a long discussion took place, and eventually the report was referred back for further consideration. Mr. Ellis, the electrical engineer, said that if single-deckers were adopted the cost of running would be practically the same as for double-deckers, while the carrying capacity would be only one-half.

The question of English *versus* foreign rails for the tramways also came before the same Council meeting. It appears that in October last year the Council decided to advertise for 2,000 tons of British manufactured rails, and Mr. Veall now moved that the tenders be open to British and foreign firms, each person or firm to state the place where the rails will be rolled. Mr. Frank Fox seconded, and pointed out what the town had saved in giving the previous contract to Dick, Kerr & Co., those rails having been made abroad. British manufacturers were unable to compete because of the heavy rents and royalties they had to pay, and the preferential rates given by the railway companies. Alderman Sir Thomas Morel stated that German manufacturers were able to compete with British because they used inferior ore. The result was that the rails were not equal to those made in this country, and especially in Wales. Two years ago steel manufacturers were exceedingly busy, but the reason why they could not tender was that the Corporation asked for rails 60 ft. long. Now, Mr. Harpur stated that he would be satisfied with a 45-ft. rail. Dowlais, Cyfarthfa, and Ebbw Vale were prepared to accept orders. American engines had turned out badly, and steel plates delivered at Belfast had been rejected because they would not pass Lloyd's test. Alderman Trounce and Mr. John Jenkins and Mr. F. J. Beavan strongly opposed the motion. Mr. Norman did not think the Council was justified in bolstering up British industries at the expense of the ratepayers. Mr. Chappell questioned whether the rails made abroad were properly inspected. After several other members had spoken, Mr. Veall replied. Mr. Harpur had told them, he said, that he would not wish to have better rails than those supplied by Dick, Kerr & Co. They were inspected both during and after construction by English inspectors on behalf of the Corporation. He failed to see why the tramway committee should be burdened with £5,000 more than was necessary.

We gather from the *Western Mail* that the motion was defeated by twelve votes to six. Tenders will therefore be confined to manufacturers in this country.

Chiswick.—At the meeting of the U.D.C. last week (Wednesday) notices were read from the Middlesex County Council and from the London United Tramways, Limited, of their intention respectively to apply for light railway orders affecting the district, and asking for information with regard to the Council's own intention to apply for an order. After a long discussion it was resolved to oppose the County Council's scheme and to proceed with the U.D.C.'s application.

Crewe.—The British Electric Traction Company has given notice of its intention to apply to the Light Railway Commissioners for an order authorising the construction and working of light railways at Crewe and Haslington.

Darlington.—The T.C. is applying to the Light Railway Commissioners for powers to construct and work light tramways in substitution for the present Darlington tramways.

East and West Molesey.—At the last meeting of the U.D.C. it was reported that the Surrey County Council had come to terms with the London United Tramways, Limited, with regard to their Bill, but it appeared that the County Council had not done anything with regard to the widening of the bridges over the Mole and Ember in the Council's district; and it was alleged that the County Council's agreement had been come to in consequence of a misrepresentation by the company that the question of bridges, which are only 18 ft. wide, had already been settled as between the U.D.C. and the company. The County Council subsequently promised "moral support" in the matter of the desired widenings. Before coming before the Committee the company have agreed to all the demands of the U.D.C., allowing double lines and widenings to the full statutory width, wood paving, and the widening of the bridges to 45 ft. The company also grant a wayleave of £100 per annum on the Council waiving the purchase clause.

France.—A commission has just been nominated by the Prefectorial Administration for the study of an electric tramway from St. Pierre de Boeuf to Givors.

Gateshead.—The Gateshead Tramway Company opened a new section, and commenced to run the new line of tramcars on the 5th inst. from Wellington Street to Sheriff Hill.

Glasgow.—The sale of Corporation tram-horses has been resumed this week.

Germany.—A series of trials have recently been made for running omnibus trains by means of accumulators on the Ludwigshafen and Neustadt, and the Ludwigshafen and Worms lines—the former of 30 kilometres, and the latter of 22 kilometres. The rolling stock comprises four automobile carriages, each provided with two electro-motors excited in series, and with accumulators of an initial capacity of 225 ampere-hours. Each of these carriages can carry 120 persons; one trailer car is attached to each, capable of seating 50 people. The accumulators are placed under the seats. Each auto-car is provided with a battery of 150 cells. The experiments already made have proved that the positive plates of these accumulators can furnish the necessary tractive power for 70,000 to 80,000 car-kilos., and the negative plates 35,000 to 40,000 car-kilos, the dead weight of the auto-carriages being about 45 tons. The construction and equipment of one auto-car costs about £2,670; the price per car-kilometre on the Ludwigshafen and Neustadt line is estimated at £1 7s. approximately, and that of the seat-kilometre about ·3d.

Halifax.—The Tramways and Electricity Committee had a lively quarter of an hour at the last monthly Council meeting. The committee recently ordered 2,000 tons of tram rails and fish plates from the Lorain Steel Company in the United States, and some time ago the Halifax borough engineer (Mr. J. Lord) sailed for America in order to witness the testing of the rails and plates. The Labour members of the Council wanted to know if it would not have been cheaper in the end to have given the order to an English firm. Other members objected to any official being sent to a foreign country on such an errand without the Council's permission, and it was moved and seconded that he be not allowed to go. The Mayor: He has been in America some days. The chairman of the Electricity Committee, Alderman Booth, explained that Mr. Lord's visit would prove of great service to the Corporation, and in one item alone he would save double the cost of his journey. In reply to a question, the Alderman denied that Mr. Lord's visit had to do with the Salterhebble "Lift" project, which the committee wish to carry out, but which is opposed by the Council.

Ilford.—A public inquiry was held on 7th inst. by Col. von Donop, into the D.C's. application for powers for borrowing £106,737 for tramways.

Loughborough.—The T.C. has sealed an agreement with the Loughborough and District Electric Traction Company. The Corporation contributes £10,000 towards the Loughborough and District Light Railway.

Manchester.—The first section of the city electric tramways was opened on 6th inst., cars being run from Albert Square to Cheetham Hill and Hightown. There was a large gathering of mayors and representatives of the numerous local authorities around Manchester. The Lord Mayor declared the car shed opened, and was presented with a gold key. The service was to be available for the public use the following day.

Morecambe.—At a U.D.C. meeting on 10th inst. a communication was read from Messrs. Heape & Ledworth, proposing that Parliamentary powers should be obtained for converting the present horse tramway system at Morecambe into one electrically propelled. The communication was referred to the Electric Lighting Committee.

Newcastle.—The *Newcastle Chronicle* says that a return has just been issued to members of the Newcastle Tramways Committee, from which it appears that when Parliamentary powers were sought for the construction of the new tramways, the total expenditure estimated was £614,250, and that the cost had now risen to £803,281. On the track itself, it is said, the Parliamentary estimate was £400,000 for forming and paving the track; but it is now estimated to be carried out for £325,000—a fact which makes the increase in the other departments all the more serious. It is not easy to reconcile these statements with the original estimates as placed before the Council. The figures, as submitted by Mr. Hopkinson, upon whose judgment the Committee and the Council relied, estimated that the whole system, track, boilers and engines and cars, all complete, could be furnished for £400,000, and that estimate the Council adopted. The ratepayers were assuredly led to believe it would be accomplished for this sum.

Oldham.—The report of Major Druitt, R.E., Board of Trade inspector, upon his recent inspection of the Lees Road and Glodwick Road sections of the electrical tramways was read at the Oldham Tramways Committee meeting on Thursday last week. He fixed the speed at various rates along the routes, and remarked upon telephone wires crossing the trolley wires without the latter being guarded. He recommended that the lines should not be certified until slipper brakes were provided for the cars. Mr. Hewitt, consulting electrical engineer, said there was very little in the report which could not be answered satisfactorily. The guard wires were all right now, and the slipper brakes were being provided. The borough surveyor and Mr. Hewitt will frame a reply to the Board of Trade.

The Borough Council last week sanctioned without discussion the advance in salary of Mr. S. W. Newington, borough electrical engineer, from £250 to £270 per annum.

At a meeting of the Electricity Committee the same night the following resolution passed by the Tramways Committee was read:—"That the Electricity Committee be requested to place the instalment of the plant which is now being laid down at the electricity station at the service of this Committee for traction purposes." The electrical engineer did not see that the request could be carried out. Had the application been made earlier in the year it might have been possible for them to so arrange matters that it could be acceded to, but now they had taken fresh orders. The chairman said that he thought they should work the station to its fullest capacity, notwithstanding the contingency of possible breakdowns. He desired to see most attention given to the running of the trams. The matter, after further discussion, was deferred to a further meeting. Later in the evening at the Council meeting the chairman of the Tramways Committee stated that he believed the Electricity Committee had sufficient power to run about 22 cars. The former wished to have at least 16 cars running by the end of August, if not more.

A lengthy discussion took place at the Council meeting respecting the proposed traffic bridge at Rhodes Bank. It is proposed to construct a new station on the other side of the railway to meet the increased demand for energy. The proposed bridge would go over the ground on which the new station is going to be erected, and divide the premises in half. Numerous contracts had been let by the Committee, and had the minutes not been adopted it would have meant a considerable delay.

St. Helens.—At a meeting of the Tramways Committee, the town clerk was instructed to apply to the B. of T. for permission to borrow £10,000 for additional electric traction plant.

Salford.—The Tramways Committee of the Salford Corporation opened a new route on Monday, starting from Victoria Bridge *vid* Chapel Street to the Swing Bridge at the docks of the Manchester Ship Canal.

Sedgley and Wolverhampton.—The British Electric Traction Company have now commenced the work of laying down and electrically equipping the line for the new tram service between Sedgley and the Fighting Cocks, the boundary of Wolverhampton borough.

Sheffield.—The accounts of the Sheffield Corporation tramways undertaking disclose a highly satisfactory state of affairs. 34,370,763 passengers have been carried, as compared with 19,209,714 for the preceding year. The horse traction sections showed a gross profit of £1,080 10s. With reference to the electric traction the gross receipts amount to £108,300 6s. 9d., and the gross expenditure to £60,733 18s. 11d., leaving a gross profit of £47,576 7s. 10d. After deductions for interest, repayment of loans, repairs and maintenance, there is a net available profit of £21,817 17s. 2d. From this sum it is proposed to take £15,000 to be placed to a special fund to provide for renewals of track, rails, machinery, electrical equipment, &c, and this amount brings the surplus account up to £51,277 7s. 7d. The amount handed over for the relief of the rates since the Corporation have had the tramways under their control amounts to £22,000.

South Lancashire.—The South Lancashire Tramways Company have definitely decided to have the generating station for the whole of their 133 miles of electrical tramways at Atherton. It was originally proposed to erect it at Leigh, but the Corporation having withheld their consent to the construction by the company of branch lines through the popular parts of Leigh to Astley connecting with Manchester and Hindley and with the Wigan routes, the company decided to change the position of their generating station. The new site at Atherton is very central for the system, which will unite Manchester, Liverpool, Bolton, Leigh, Wigan, and Warrington.

Staines.—The U.D.C., at a special meeting for the discussion of the proposed Middlesex County Council scheme for a light railway from Staines to Hampton, decided to approve of the scheme generally, but to oppose on certain points of detail in which the Council are concerned as property owners. As to the second proposed line from Staines to Hounslow, the Council decided to dissent from the proposals as affecting a strip of land forming part of Shortwood Common.

Stourbridge.—The opening of the electric tramline through Stourbridge is close at hand, presuming the Board of Trade give the necessary permit. The line has been already tested by the passage of a car through High Street.

Woolwich.—The Borough Council has adjourned the consideration of the proposal of the Auxiliary and Light Railways and Tramways Company to construct a line from Woolwich to Eltham, and has decided to approach the London County Council on the subject of improved local tramway communication.

West Hartlepool.—Mr. Garcke, managing director of the Hartlepool Electric Tramways Company, and others, last week waited upon the Works Committee to discuss the best way of dealing with the working of the tramway service in the borough in the future. The consideration of the matter was adjourned to enable the company to submit particulars of their proposals, and for the town clerk to submit a report upon the terms of the tenure of the company under their several orders.

(Continued on page 1025.)

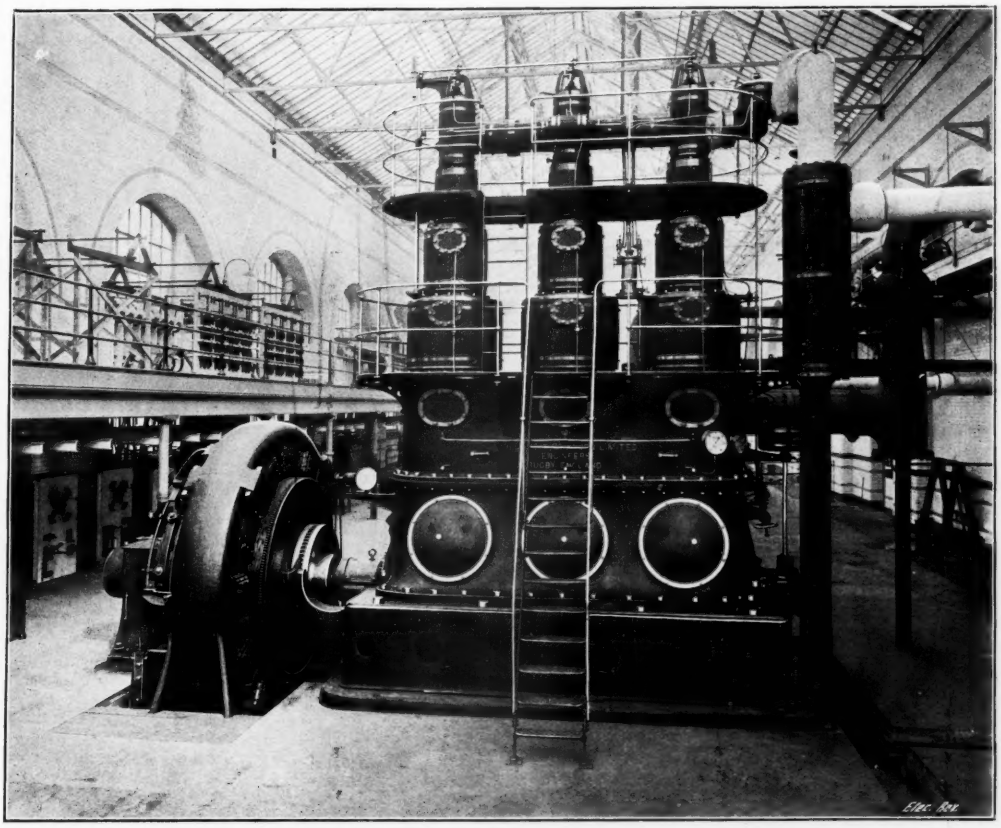
GLASGOW INTERNATIONAL EXHIBITION, 1901.

I.

THE Exhibition may now be considered to be practically complete as far as the engineering trades are concerned; the last of the stalls in the Machinery Hall was thrown open to the public view last week, the Pavilions in the grounds are receiving the finishing touches, and there remain only minor additions to be made to the exhibits. The present may therefore be an opportune time to offer a few remarks on the leading features of the show.

As to its importance to electrical and mechanical engineers, there cannot be two opinions. The collection of finished machinery, fittings and accessories, as well as of machine tools and other adjuncts to the manufacture of electrical apparatus, is without doubt unprecedented in this country. It must be admitted that there is little to justify the epithet "International," in regard to steam engines and boilers, of which there is, we believe, not a single example from abroad save the Niclausse boiler, which itself will shortly be made in this country. This deficiency is to be greatly regretted, as the opportunity is lacking of comparing our own practice in this respect with foreign methods. However, there is no dearth of electrical machinery of every description of both British and foreign manufacture.

There is little to remark upon in the collection of boilers; both fire-tube and water-tube types are well represented, with and without superheaters. One interesting feature consists in the application of producer gas to boiler-firing; this has been so arranged that the results obtained in this way, and by firing with coal, can be compared under similar conditions. We cannot but think, however, that the gas would be employed to better purpose in a gas engine without the interposition of the steam generator. Every transformation is a source of inevitable loss; and the fewer there are of such transformations, the better will be the efficiency and reliability of the system considered as a whole. The large gas engine is no longer in the dim distance of futurity; its era has already dawned, and the new century will still be in its teens when the 1,000-H.P. "gas-dynamo" has ceased to be a novelty. Digressing further for a moment, we may draw attention to the fact that already there are two engines in the Exhibition—one of 100 H.P.—which do not even require their combustible served up in the form of gas, but are capable of consuming *coal*—pulverised, but not otherwise changed from its natural state!



The above illustration represents a 1,200-H.P. three-crank triple-expansion Willans central-valve engine, running at 230 revolutions per minute, and coupled to a compound-wound Crompton dynamo, rated at 700 KW., 520 volts. The combination will give 960 KW. for one hour at 510 volts. This set, which is installed at the Corporation Electricity Works, St. Andrew's Cross, Glasgow, is a duplicate of a set in the Exhibition.

WILLANS-CROMPTON 1,200-H.P. STEAM DYNAMO.

Of feed-water pumps, there is a great variety; in this connection it is especially noteworthy that the steam-thrown valve, which has earned such an excellent reputation in electricity works, is being adopted by several well-known makers, while numerous examples of electrically-driven pumps are exhibited. Other accessories of boiler plant, such as oil separators and filters, feed-water heaters, and steam-traps, are abundantly represented.

The main features of the engines exhibited are the very marked tendency to adopt high speeds and forced lubrication,

and the prevalence of the single-acting type—the latter with splash lubrication. In fact, the low-speed type of engine is distinguished by its rarity. This, perhaps, is the necessary consequence of the fact mentioned above—that the foreign-made engine is not represented. No stronger evidence of the tendency of present British practice to advance along the lines laid down by our central station pioneers could be adduced than that furnished by a visit to the Exhibition; direct coupling and high speeds are *en règle*, rope and belt driving wholly absent (except where a motor is coupled to a generator for exhibition purposes).

Passing to the electrical generators, one cannot fail to be struck by the immense change which has come over the British dynamo in a space of but a few years; where one used to see nothing but two-pole smooth core dynamos and copper-type alternators, one now finds universal adherence to the slotted core and multipolar field. Is it not remarkable that in so many cases, after trying all manner of devices, we turn again to one of the earliest known forms—better designed it may be, but still not far removed from its fore-runner? The slotted core preceded the smooth core; the multipolar dynamo was early in the field, and the iron-cored alternator came before the copper type. So it is with accumulators, switches, and many other kinds of apparatus—even the single-acting engine! This tendency may be ascribed to the virtues of simplicity and durability, than which not even efficiency is more highly prized.

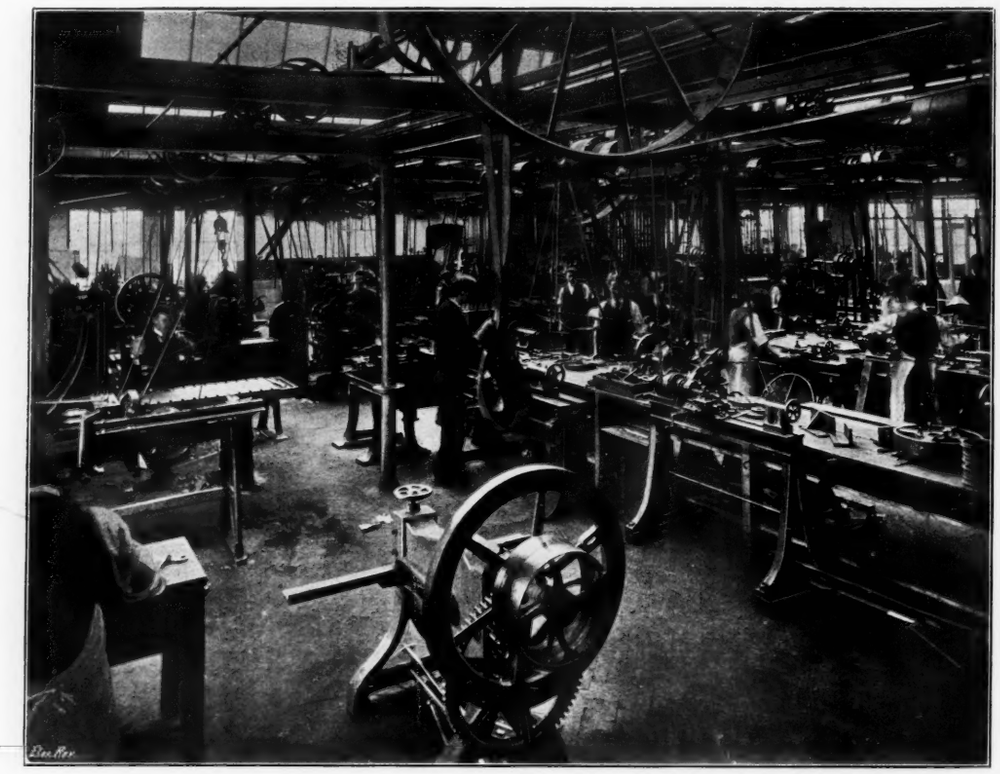
Most of the armature coils are formed, and the winding is almost always of the "barrel" type, even in the case of some of the few two-pole drums exhibited. There is a marked inclination to shaping the pole-pieces in a special manner to shade off the field—either by bevelling the pole-tips in one or more of the three possible ways, by skewing the pole-shoes, or by using a material of inferior magnetic conductivity for the pole-tips. Needless to say, in almost all cases carbon brushes are employed, and here practice is most diverse. All kinds of brushes and brush-holders are to be seen, good, bad and indifferent. Some designers seem to think that anything is good enough for a brush-holder; others, that nothing can be too good! With the latter we are entirely at one; it is impossible to be too painstaking in the design of a carbon brush-holder, or—and this is of crucial importance—in ensuring good connection between the brush and the holder.

The old fallacy, that a draught of air can be induced through an armature core by skewing the blades of the spider *inside* it, crops up in one or two cases. It should be understood by now that this is *not* the way to design a fan.

It is a noticeable fact that but little alternating machinery of British manufacture is shown. Exception should be made in the case of one or two firms, but it is plain that the question of patent rights has a powerful retarding effect upon those who would manufacture poly-phase induction motors in the absence of this restriction. Doubtless a very different state of things will prevail at the next great exhibition in this country. In this respect the foreign exhibitors have things very much their own way.

A most important feature of the show is the large number and variety of direct current motors exhibited. In this department British manufacturers are not a whit behind their foreign competitors; the excellence of the design and workmanship of their products leaves little to be desired. Further, not content with merely making motors, in very many cases they have got out special lines of motors coupled to pumps, winches, coal cutters, fans, motors fitted with reducing gear and belt pulleys, large and small, open and enclosed. This section is indeed worthy of special study. Moreover, it is a sign of the times. The number of manufacturers of all kinds who have been quietly reorganising their works and putting in electric transmission plants of their own, is astonishing. Some of these installations are very large and complete, including the lighting of works and ship-yards, and the driving of practically the whole of the machinery. Such facts as these, combined with the extra-ordinary progress evidenced by the present display, go far to justify us in our belief that British manufacturers, though temporarily outstripped in point of equipment by their foreign rivals, will not be content with any but the foremost position, and are already girding up their loins for the race.

Passing on to minor apparatus, we may mention the fact that at more than one stall materials for overhead trolley



Messrs. Elliott Bros. "Century" Works.—Machining Department.

construction, made in this country, are displayed, as well as tramway and railway motors and controllers.

Switch gear shows a general tendency to the knife-blade type—common enough years ago, as we remarked above, but now greatly improved in design and construction. Insulated cables and wires, which form such a large proportion of the equipment of distribution systems, are nevertheless

"Century" Works.—Part of Test Room.

not very largely represented. Lamps, fittings, and small accessories receive a fair amount of attention, as well as telegraph and telephone apparatus.

In conclusion, we feel bound to give utterance to the universal complaints of the exhibitors on the score of the arrangements made by the authorities for the accommodation of their exhibits and their representatives.

Bound by red tape and menaced by unnecessary and exacting regulations; immersed in an atmosphere of steam and vitiated air, for lack of proper ventilation; absolutely without the slightest facilities for cleanliness or refreshment save those accorded to the general public—and at the same prices—they feel that they have not received due consideration on the part of the powers that be. One important steam-dynamo exhibit cannot be run at all, on account of the inadequacy of the foundations provided by the Exhibition authorities, the site being of a very boggy and elastic nature. Our own grievance lies in the fact that we are debarred from taking photographs in the Exhibition, a grievance which is necessarily shared by our readers. Surely the experience gained through the Exhibition of 1887 should have better prepared the Glasgow Corporation to carry out the present Exhibition in the most reasonable and satisfactory manner possible. It is a great success; but that is in spite of these arrangements.

MESSRS. ELLIOTT BROTHERS' WORKS AT LEWISHAM.

The foundation of this well-known firm dates from the very beginning of the last century, for William Elliott was apprenticed to William Backwell, drawing instrument maker, in the year 1795, and started in business on his own account in 1800, working for the trade as a drawing instrument maker in Sash Court, Gray's Inn Lane. Having gained a great reputation for excellence of work, he took a shop in High Holborn in 1807, with a small workshop attached, and added to his business the manufacture of surveying and mathematical instruments.

The founder died in 1853, but previous to this, in 1850, he had taken into partnership his two sons, Frederick Henry and Charles Alfred, the style of the firm being Elliott and Sons. On the father's death the business was continued by the sons under the style of Elliott Brothers. From time to time the workshop was removed to new premises, and the business of Watkins and Hill, philosophical instrument makers to the Royal Institution, &c., which had been carried on for many years, was taken over by Messrs. Elliott Brothers. A few years later the site was required for the building of Charing Cross station, and before the removal was effected the railway company commenced to undermine the foundations, with the result that the whole of the workshops at the rear of the building collapsed! The firm then took works at 112, St. Martin's Lane, Mr. Charles Becker joining the firm as works manager, whilst the retail branch was removed to

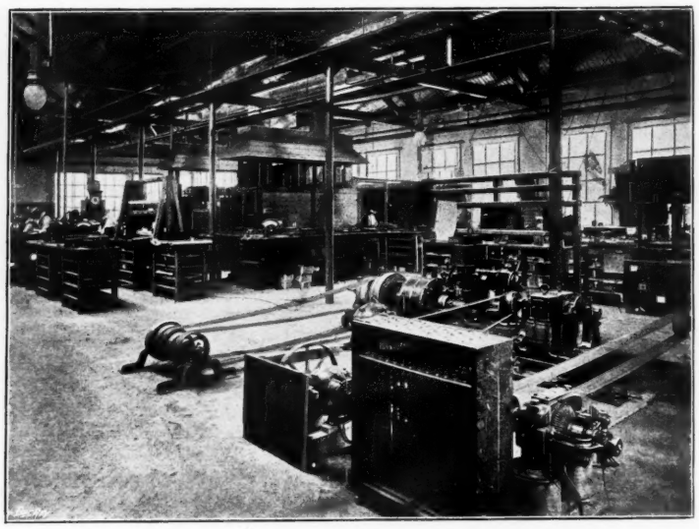
"Century." Works.—Assembling Department.

449, Strand. Charles Elliott at this time retired from the firm, leaving F. H. Elliott sole proprietor.

Shortly after this, about 1864, Elliott Brothers were engaged in making electrical standards for the B.A. committee, and a large number of testing and signalling instruments for the submarine cable laying and working schemes

which were then being rapidly organised ; it was therefore necessary to get additional works to meet the increased demand, and in 1868 they added works at 102, St. Martin's Lane.

In January, 1873, F. H. Elliott died suddenly, leaving the business to his widow. In the same year Mr. Willoughby Smith joined Mrs. Elliott in the business, neither taking any active part in the work. Mr. Becker became the managing partner, and Mr. W. O. Smith joined the firm as his father's representative. In 1875 Mr. Becker died, Mr. W. O. Smith succeeding him as manager of the business.



Test Room.

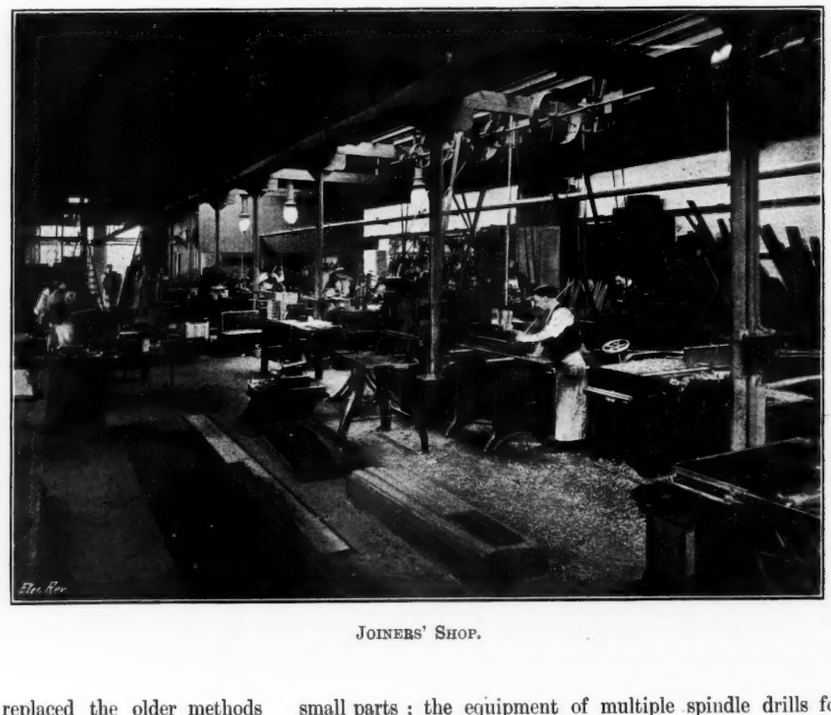
In 1876 it was found necessary to still further enlarge the works. The leases of 101 and 102, St. Martin's Lane, adjoining, were acquired, the old buildings were pulled down, and new works erected ; these were completed and occupied early in 1878.

Mrs. Elliott died in 1881, and Mr. W. O. Smith entered into partnership with his father, Mr. Willoughby Smith, who died in 1891. In 1893, Mr. W. O. Smith entered into arrangements with Mr. G. K. B. Elphinstone, the proprietor of the business of Theiler & Son, of Canonbury, telegraph instrument makers, to amalgamate the businesses under the style of Elliott Bros., Mr. Elphinstone joining Messrs. W. O. Smith and W. S. Smith in a new partnership which exists at the present time.

The works, built in 1876, not being convenient for the requirements, owing to the altered nature of the work and the amount of machine work which had replaced the older methods necessitating more space, a site was obtained at Lewisham and the commodious buildings hereafter described were erected ; the removal to them was completed early in 1900, just 100 years after the business was started by William Elliott—hence the name " Century Works."

The buildings of this factory have been carefully laid out with the object of facilitating supervision and the handling of materials, the whole of the manufacturing work being carried out on the ground floor. There are four separate buildings. The cabinet makers' shop, which is separated from all the others on account of fire risk, is well equipped with circular saws, planing, dovetailing and moulding machines, pattern-makers' lathes, &c. At one end of this shop there is a timber stack, with sides well open to the air, for drying planks, and all the machining is done at this end, the work being passed gradually along the shop until it reaches the painting and polishing room, which is partitioned off on account of dust.

The main workshop, 160 ft. × 80 ft., contains a good outfit of machine tools. At one end is partitioned off a tool room, well equipped with all the latest tool-making appliances—Brown and Sharpe's milling machines, grinding machines, &c., and all the jigs, machine fixtures, gauges, cutters, &c., in use all over the factory are made and kept in this room. Here are also stored very complete sets of internal and external limit gauges for the manufacture of interchangeable parts, with standard gauges of all descriptions, and all grinding and repairs to tools are carried out here. At the same end of the shop are a large number of milling machines, horizontal, vertical, and of the well-known Lincoln type, also profiling machines for pieces of irregular shapes. Towards the central part of the shop are lathes and drilling machines in large numbers and of various sizes, from heavy engine lathes for cases, capstan lathes for the production of terminals and small turned work, down to bench lathes of the Pratt & Whitney and Boley types for the manufacture of small parts ; the equipment of multiple spindle drills for jig work is particularly complete.



Joiners' Shop.

At the further end of the shop the mechanical work is put together and completed ready for passing to the inspection and testing departments, and here are to be seen Wheatstone automatic telegraphic apparatus and other elaborate tele-

graphic apparatus made by the firm, and a large section for putting together the well-known recording instruments in large numbers.

This shop is particularly well lighted from the roof, which is of the saw tooth construction, with the steep glass slopes facing north; a noticeable feature exists in the fact that the heating is effected by overhead hot water pipes, so as to avoid unnecessary waste of floor space. The arrangement of the overhead shafting and pulleys is also noteworthy; all the bearings for these are clamped on to a steel framing carried quite independently of the roof, and the special form of clamps employed enables changes of position of shafts, &c., to be made in a few minutes. The power is supplied by means of several 4-H.P. Lundell motors, each driving a section.

The third block comprises the offices, stores, test room, packing room, &c. On the first floor are the offices for correspondence, book-keeping, cost keeping, &c., which are well fitted up with any appliances which tend to save time and improve method, such as card indexes and Shannon files for correspondence. The drawing office is a fine light room with the usual fittings, an arc lamp device for blue prints, and a strong-room fitted with drawers for the safe keeping of originals. On the ground floor is a store containing an immense variety of raw material, and a section fitted up with shelves and trays for the storage of stock parts which are made up in quantities.

All these parts pass through an inspection department, where they are checked against gauges before being passed through to the stores as correct. In the inspection department also an examination is made of all mechanical work before it leaves the factory or is passed through to the test-room for the electrical department.

The test room is a fine room, 90 ft. × 50 ft., lighted from the roof and round three sides. Here are fitted up potentiometers, Wheatstone balances, and a very complete equipment for the calibration of voltmeters and ammeters, all the tests being made with current supplied by accumulators capable of arrangement for very large currents. At one end of the test room arrangements are made for alternating current work, several small machines furnishing currents, the frequencies of which can be varied over very wide limits.

The fourth block comprises the smiths' shop, a foundry, and the engine room, in which is a 100-H.P. Stockport gas engine driving a 200-volt continuous current generator, the engine running with producer gas made in a plant at one side of the building. A feature of this block is a lavatory and hat and coat room for the workpeople. This has an entrance into the yard and one opposite the doors of the main workshops.

Our illustrations serve to give some idea of the manner in which the above arrangements have been carried out; it will be seen that the works are thoroughly up-to-date. It is interesting to compare these with the original small instrument shop of 100 years ago, from which this important concern derived its origin!

ELECTRIC TRACTION NOTES.

(*Continued from page* 1020.)

Sweden.—Different projects are at present under study for the development of the electric energy necessary for working the West Coast of Sweden Railway. In this connection the engineer, Richert, has just finished the examination of a waterfall situated about 1 kilometre from the station of Laholm. At normal flood this waterfall affords a supply of 40 cubic metres per second, the minimum being 22 cubic metres. It is believed, however, that the regular supply could be easily increased to 60 cubic metres per second. In order to allow the free passage of fish, an overflow of 5 cubic metres per second should be provided for before reaching the turbines. Although the supply might be raised from 22 to 60 cubic metres per second, the author of the project believes that the installation would be more economic in taking the minimum supply as a basis of calculation, and supplying by a steam engine the difference between the resulting power and that required. The utilisable fall is 4·5 metres, giving 1,250 H.P. The cost of installation would reach 1,200,000 crowns. The cost of installation per horse-power would thus be 800 crowns, and the annual cost per horse-power 80 crowns. If it were desired in the future to exceed 1,250 H.P., the installation would cost 300 crowns per horse-power, and 55 crowns per horse-power per annum. These calculations are based on the complete utilisation of the motive power during normal flood; this would depend greatly on the organisation of traffic. Mr. Richert finally advises that, before coming to a decision on the subject, an examination should be made in the vicinity with a view to determining if another and perhaps more advantageous waterfall does not exist.

Taunton.—The strike of the labourers who are engaged in preparing the roads along the main thoroughfares in Taunton for the laying of the lines for the new electric trams, terminated on Monday, June 3rd, when the men, numbering about 50, resumed work. The labourers were paid at the rate of 6d. per hour and others 4½d. per hour. The work only began last Wednesday, and on Friday those receiving the lower rate of pay demanded 6d. The contractor offered them 5d. per hour, which was refused, and the whole of the men at midday went out on strike. On Saturday, it being market day with consequently additional traffic in the town, the part of the road which had been dug up was filled in pending the termination of the strike. Traffic over the greater part of Station Road was thus resumed. An agreement was subsequently come to whereby those who received 4½d. accepted 5d. per hour, which was originally the amount the contractors offered. Progress is being steadily made with the work, and the excavations along the Station Road have reached as far as the Canal Road. The British Electric Traction Company, who are carrying out the undertaking, are under an agreement with the Taunton Town Council to complete the trams by August 1st, and the Council have agreed to supply the electric power, and are applying to the Local Government Board for sanction to a loan for making the necessary extension of plant at their electric light works.

West Bromwich.—The T.C. have now completed arrangements for the purchase of the portion of the tramways belonging to the South Staffordshire Tramways Company within their district. The lines will be transferred shortly and worked by electricity under the control of the Corporation.

TELEGRAPH AND TELEPHONE NOTES.

Cable Communications Committee.—Meetings of this Committee were held on Monday and Tuesday. The *Times* states that evidence was given by Lord George Hamilton (Secretary of State for India), by Mr. W. S. Andrews, Mr. T. W. Stratford-Andrews, and Sir W. Brooke, representing the Indo-European Telegraph Company; and by Mr. W. S. Andrews, Mr. Brown, and Mr. Quick, representing the West India and Panama Telegraph Company.

Chi-Fu and Wei-Hai-Wei Cable.—In the House of Commons last week the agreement made on April 23rd between the Government and the Eastern Extension, Australasia, and China Telegraph Company, Limited, for the provision and working of a submarine cable between Chi-Fu and Wei-Hai-Wei, was approved of.

French Telegraphs.—*Liberté* says that the Colonial Committee has received an assurance from the Government that no time would be lost in laying down a submarine cable between Brest and Dakar and in establishing in the Far East a network of telegraph lines encircling Indo-China. The Government also gave its consent to the creation of a vast Atlantic system.

Glasgow Telephones.—At the last meeting of the Corporation, Mr. James Alexander in moving the adoption of the minutes of the Telephone Service Committee, stated that a connection had been made between the Corporation Exchange and the Government trunk wire system. An hour ago he had been called out to speak over the wire to London, and he was glad to say that the hearing was good, and that the instruments appeared to be working well.

Post Office Telephones.—It is stated in various papers that the Post Office London telephone system will be placed in operation at the beginning of September next, in the City area, Westminster, and a portion of the Thames Valley Extension.

Postal Grievances in the House of Commons.—There is a consensus of opinion among members of Parliament and lobbyists that the Postal Servants came near to defeating the Government on Friday evening last (June 7th). The majority eventually secured was one of the lowest of the Session. A remarkable combination of circumstances led up to the position. The new rules governing supply make it almost impossible to estimate the precise day upon which any particular vote will be taken. Although the Postal vote had been on the paper throughout the recess, nobody felt quite sure that it would be taken. Late on Thursday it became probable, however, that Friday would see what debate could be arranged. Postal employés all over the country were advised, and soon members of Parliament began to receive wires from their constituencies reminding them of their election promises to vote for a committee of inquiry. The House was an exceptionally thin one owing to the expected slackness of business, and also to the fact that it was Oaks day. When Conservative after Conservative rose to support the motion for an inquiry, the Government whips scented disaster and soon were straining every nerve to bring up supporters. It was certain that had the vote been

taken before 9 o'clock the Government would have been defeated. Mr. Balfour's impassioned denunciation of Civil Servants' methods was unmistakably the application of the whip to his fold. The result of the debate shows one thing. Whatever view we take of the methods of the Postal employés, it must be confessed that those methods are highly successful in obtaining support in the House of Commons and demonstrate a well ordered compact organisation which by reason of its alliance with the Trades Unions of the country wields immense political power. So far as the continuance of the agitation goes, we are assured that the agitation being caused by well-founded grievances will be continued until a remedy is applied. So far as the threats of disfranchisement go, Mr. Hanbury, the men say, made them so familiar that they have lost their power to frighten.

Swedish Telephones.—The Swedish Government proposes to instal a telephone between the Isle of Gotland and the mainland. During last week a survey of suitable terminal points was made. Amongst those proposed are Dalarö, Nynäs, Vestervik, Oskarshamn, and Kalmar *vid* the Isle of Oland.

The Telegraph Wire Export Trade.—According to the annual report of the Southampton Chamber of Commerce, telegraphic wires and apparatus of the value of £14,279 were exported from that port during 1900 to the following countries of destination:—Azores, £1,910; Islands in Pacific, £1,300; Brazil, £1,444; Argentine, £3,996; St. Helena, £2,693. May proved to be a somewhat quiet month as regards the exports from this country of telegraph wire and apparatus connected therewith, the shipments during May only attaining a value of £245,333 as compared with the £548,709 in the preceding month, and £395,808 in May last year. The returns for the year to date are, however, very satisfactory, showing as they do a total of £1,623,312 for the five months ending with May as contrasted with £1,411,716 in the corresponding period of 1900.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Latakia-Cyprus	June 20, 1899 ..	..
Para-Maranham	March 1, 1900 ..	..
Gibraltar-Tangier	June 11, 1901 ..	..
Landlines:—		
Bolama-Bissao	May 19, 1901 ..	..
Cayenne-Pinheiro	April 20, 1901 ..	..
Saigon-Bangkok	May 29, 1901 ..	June 8
Saigon-Bangkok	June 11, 1901 ..	June 12
Pekin-Kalgan	June 14, 1900 ..	..
Maimatchin-Kalgan	June 30, 1900 ..	..

Turkish Telegraphs.—The *Levant Herald* reports that the Turkish Administration of Posts and Telegraphs have commenced operations at Maan in pursuance of the decision to double the telegraph line between Selt and Mecca.

West Hartlepool Telephones.—Application is to be made to the Postmaster-General for a license to establish a municipal telephone in the borough.

Wireless Telegraphy.—The first Government installation of Marconi's wireless telegraphy on the coast is being set up at Dover, the site being on the western fortifications overlooking Shakespeare's Cliff, near the coastguard station. The mast is to be 180 ft. high. The installation is to enable vessels of the Navy to communicate with the shore.

Rathlin Island has now been placed in direct communication with the Post Office telegraph system in Ireland by means of Preece's induction system.

The Canadian Government has decided to conduct a series of tests with wireless telegraphy as an aid to navigation in the Gulf of St. Lawrence. Instruments have been cabled for to England. It is intended to place one operator at Belle Isle, and another on board a Government steamer. Shipping men here are of opinion that the installation of the Marconi system would reduce the dangers of navigation at the entrance of the St. Lawrence by 75 per cent.

Dalziel says that the French Government is dissatisfied with the results of the aerial wireless telegraphy experiments carried out by a specially-appointed board of experimenters. "As a consequence a series of experiments will be conducted to test the wireless subterranean system. The failure of the aerial system is said to be that whereas one day a message can be sent over 40 miles, the next day the same apparatus cannot send a message 10 miles.

CONTRACTS OPEN AND CLOSED.

OPEN

Belfast.—June 21st. The Corporation wants tenders for sinking an artesian well, and supplying pumping plant. See "Official Notices" June 7th.

Bermondsey.—July 1st. The Borough Council wants tenders for electricity meters, demand indicators, and main fuses. See "Official Notices" June 7th.

Blackburn.—June 21st. The Council wants tenders for wrought-iron tubes and steam coal required during the next 12 months. See "Official Notices" to-day.

Bradford.—The Corporation is inviting tenders for the supply of 100 electric motor tramcars.

Brazil.—July 8th. The Foreign Secretary has received a despatch from H.M. Consul-General at Rio de Janeiro, stating that tenders are invited by the Brazilian Government, to be received not later than July 8th, for the supply of electrical machinery for the hoisting and transporting of locomotives at the Engenho de Dentro Works. Some particulars may be examined at the Commercial Department of the Foreign Office.

Cleckheaton.—June 22nd. The U.D.C. wants tenders for engines and dynamos. See "Official Notices" June 7th.

Edinburgh.—June 15th. The Corporation wants tenders for ash conveying plant for Dewar Place station. See "Official Notices" May 24th.

Epsom.—June 22nd. The Council wants tenders for D.C. meters and cut-outs. See "Official Notices" to-day.

Erith.—June 24th. The U.D.C. wants tenders for Lancashire boilers, economiser, pumps, piping, condensing plant, steam alternators (high speed engines, three-phase alternators), switchboard, crane, transformers, sub-stations, mains and road work, arc lamps and posts, and station lighting. See "Official Notices" June 7th.

Exeter.—June 28th. The Council wants tenders for water-tube boilers, steam alternators, switchboards, coaling apparatus, tanks, &c. See "Official Notices" May 10th.

Great Yarmouth.—June 26th. Tenders are wanted for additions to the electric lighting station. Specifications can be seen at the Town Hall. Tenders to Town Clerk, Town Hall.

Holland.—June 15th. The Secretary of State for Foreign Affairs has received a despatch from his Majesty's Consul at Amsterdam, stating that tenders are invited by the South Holland Electric Railway Company, to be received not later than June 15th, for the supply of 3,600 tons of steel rails with appurtenances.

Hurst.—June 19th. The U.D.C. invites tenders for the manufacture and supply of the whole or any part or parts of the following materials for electric tramways, viz:—About 250 tons of 7-in. steel girder rails, 22 tons of fishplates and soleplates, 13 complete sets of points and crossings, six pairs of drain rails, 120 cwt. of tie-bars, and about 110 cwt. of nuts, bolts and washers. Plans may be seen at the office of Mr. Edward Garside, Town Hall Chambers, Ashton-under-Lyne, from whom specifications and forms of tender may be obtained on payment of three guineas. Tenders to Mr. John Whitworth, solicitor, clerk to the Council, Booth Street Chambers, Ashton-under-Lyne, by June 19th.

London.—June 17th. The Guardians of St. Marylebone want tenders for electric light wiring and fittings for the new Able Bodied Block of their workhouse. See "Official Notices" May 31st.

Leigh.—June 22nd. The Corporation wants tenders for electricity meters (12 months supply). See "Official Notices" to-day.

Mansfield.—July 12th. The Corporation wants tenders for Lancashire boilers, stokers, pumps, economiser, 200-kw. steam generators, motor transformers, condensing plant, switchboard, battery, crane, mains, arc lighting, meters, and workshop equipment. See "Official Notices" June 7th.

Nelson.—June 25th. The Electricity Committee wants tenders for a travelling crane. See "Official Notices" to-day.

Norway.—June 26th. The Norwegian State Railway authorities at Christiania are inviting tenders until the 26th inst. for the supply of 47 tons of galvanised iron wire, 12,800 porcelain insulators, and 9,000 insulator supports.

Poplar.—July 2nd. The Electricity Committee wants tenders for multiple core lead-covered feeder and network cable and accessories. See "Official Notices" to-day.

Spain.—June 24th. Tenders are being invited until the 24th inst., by the municipal authorities of Colmenar Viejo (Madrid province), for the concession for the electric lighting of the town during a period of 20 years. Tenders are to be sent to El Secretario del Ayuntamiento de Colmenar Viejo (Madrid), whence particulars may be obtained.

Spain.—The *Board of Trade Journal* for June 7th says that the *Madrid Gazette* of 29th ult. contains a notice calling for tenders, which will be opened on July 30th next, at noon, in the Ministry of Agriculture, Industry, Commerce and Public Works in Madrid, for the establishment and working for 60 years of an electric tramway from Cadiz to San Fernando, with a branch to La Carraca. Competition will turn, firstly, upon a reduction from the scale of fares and freights stated in the notice, and then, in the event of two similar propositions being presented, upon a reduction from the maximum term of the concession. It is noted that a

petition exists for the concession, and that the author of it has certain preferential rights. The plan and statement of special conditions of the concession may be seen at the Ministry named. A provisional deposit of 18,118 pesetas, or about £524 8s., is required to qualify any tender.

The same *Gazette* for 31st ult. contains a notice calling for tenders for the installation and working for 20 years of an electric light system for the town of Alcalá de Guadaira (Province of Seville). The maximum payment by the Municipality is fixed at 8,000 pesetas, or about £231 19s. per annum, for which 210 incandescent lights of 10-C.P. each, besides what may be required in the Municipal Offices, prison, night schools and town clock, have to be provided. Tenders will be opened at 11 a.m. on the day after the notice has appeared 30 times in the *Madrid Gazette*, in the Municipal Buildings of the town. A provisional deposit of 400 pesetas, or about £11 12s., has to be made beforehand to qualify any tender. The same *Gazette* contains Royal Orders authorising the purchase in France and Germany, without the formalities of calling for tender, of sundry articles required by the Artillery, by the Artillery Factory at Trubia, by the Brass Foundry at Seville, and by the Central Shooting School.

Stepney.—June 26th. The Electrical Committee wants tenders for "Conradty" arc lamp carbons for a year. See "Official Notices" to-day.

Sutton Coldfield.—June 15th. The Corporation wants tenders for D.C. meters and cut-outs. See "Official Notices" June 7th.

Turkey.—June 17th. The General Administration of Turkish Posts and Telegraphs in Constantinople is inviting tenders until June 17th, for the supply of the wire and insulators necessary for the telegraphic wire connections with India.

Walthamstow.—June 14th. The U.D.C. wants tenders for electric light meters. See "Official Notices" May 31st.

West Ham.—June 25th. The Council wants tenders for three 500-KW. C.C. tramway-generators, and 850-I.H.P. steam engines; 11 water-tube boilers. See "Official Notices" June 7th.

Whitehaven.—June 24th. The Corporation Lighting Committee is inviting tenders for the purchase of about 20 tons of second-hand rubber-covered cables. See "Official Notices" to-day.

Wigan.—June 18th.—The E.L. and Tramway Committee wants tenders for 12 double-deck single truck electric cars. See "Official Notices" June 7th.

CLOSED.

Bradford.—The Corporation has accepted the tender of Messrs. Thornton & Crebbin, engineers, of Bradford, for a five-ton electric travelling crane for the Thornbury tram depôt for the sum of £355.

The Guardians have accepted the tenders of Mr. G. A. Steinthal, of Bradford, for the completion of the electric lighting installation at the workhouse.

Darlington.—Messrs. J. & H. McLaren are to supply a new engine and dynamo for the electricity works at £3,450, and an application is to be made to the L.G.B. for £27,500 loan for extensions.

Doncaster.—The Tramways Committee has accepted the tender of "Gielgud" for rails, cross-ties, &c., for the tramways. The surveyor is inquiring whether the Continuous Joint Company can make their joint to fit the section of rail adopted. Tenders are to be invited for the underground cables required, also for overhead equipment and rail-bonding.

France.—The French Ministry of Posts and Telegraphs in Paris has just given out the following contracts:—The India-Rubber and Gutta-Percha Company, of Persan-Beaumont (Seine et Oise), 15 kilometres of lead-covered five-conductor cable and 12 kilometres of lead-covered seven-conductor cable; Messrs. G. and H. De La Mathe, of Gravelle St. Maurice, 12 kilometres of lead-covered seven-conductor cable; and La Société des Telephones, of Paris, 25 kilometres ditto.

Fulham.—The Borough Council has accepted the tender of the General Electric Company, Limited, for the supply of Robertson lamps, arc lamps and accessories, fuse wire, tape, &c., as required until March 31st, 1902.

Holland.—The Allgemeine Electricitäts Gesellschaft, of Berlin, has secured a contract to establish a municipal central station in the town of Groningen. A Dutch firm—Messrs. Stock Bros., of Hengeloo—will supply the necessary steam engines.

Hornsey.—The D.C. on Monday accepted the tender of Messrs. Braid, Pater & Co., of Bow Churchyard, E.C., for the erection of the electric lighting station at Hornsey for the sum of £13,777. This was the lowest tender, the highest being for £16,970.

Hull.—Messrs. Oliver & Co. are to supply the Corporation with 12 D.C. arc lamps with posts, &c., for street lighting for £368.

Newcastle.—The Tramway Committee has accepted the tender of Dick, Kerr & Co. for 1,000 tons of rails and fishplates at £6 8s. 9d. and £12 10s. per ton respectively. The battery is to be supplied by the E.P.S. Company at £2,117. Tenders submitted by Mr. Veitch for building car sheds have been accepted at £5,178 and £3,946 respectively.

Rhyl.—The Hart Accumulator Company, Limited, have secured the order for the supply of storage battery required for the electric lighting works.

Sheffield.—Mr. S. E. Fedden, the chief engineer and general manager of the Corporation electric light department, has been authorised to purchase from Messrs. C. A. Parsons & Co., a 300-KW. turbo two-phase alternator at an approximate cost of £2,700.

Swansea.—The E.L. Committee received 15 tenders for two-phase motor alternators for supplying current to the outside districts, and Mr. Manville recommended the acceptance of that of the International Electric Company, of Liège, at £1,470. Mr. Cawthra, the resident electrical engineer, said, when the matter came before the Council, that having regard to the character of some of the foreign machinery which had already been put up in the Corporation electric works, he would not advise the Committee to go out of England for more machinery. He hoped his objection would be strong enough to postpone the acceptance of the lowest tender until he was far more satisfied with the German plant at the local station. As to the switchboard, the less said about that the better. It was a switchboard, but not what it should be. Nine-tenths of the foreign machinery was of different standards, with the result that when bolts, &c., were rendered useless they could not be replaced, except at great delay.—Alderman Howel Watkins thought this a very serious objection.—A suggestion made by Mr. David Davies that Mr. Cawthra should embody his objection in a report to Mr. Manville was agreed to, the tender to be in the meantime conditionally accepted.

Swindon.—The Corporation on Tuesday affixed the Corporate seal to the contract with Messrs. Siemens Bros. & Co., Limited, for the supply of two steam dynamos for the generating station.

Walsall.—The T.C. on Monday accepted the tender of Thomas Parker, Limited, for supplying a new transformer required for the Frier Street sub-station for £780, and for supplying a spare armature for such transformer for the sum of £266.

Wolverhampton.—The T.C. on Monday accepted the tender of Messrs. Thomas Parker, Limited, amounting to £415, for the extension of the switchboard; and the tender of Messrs. Higginbottom & Mannock, of Manchester, amounting to £607, for a crane for the tramway station.

FORTHCOMING EVENTS.

Friday, June 14th.—At 5 p.m. Physical Society meeting at the rooms of the Chemical Society, Burlington House. Papers on "Herr Jahn's Measurements of the Electromotive Force of Concentration Cells," by Dr. R. A. Lehfeldt, and "Exhibition of a set of Specimens of Jena Glass," by Prof. S. P. Thompson, F.R.S.

At 9 p.m. Conversazione of the Institution of Electrical Engineers.

Wednesday, June 19th, 20th, 21st and 22nd. Annual Convention of the Municipal Electrical Association at Glasgow and Edinburgh.

Thursday, June 20th.—At 8 p.m. Chemical Society. Among the papers down for reading is one "On the Decomposition of Carbon Dioxide, when submitted to Electric Discharge at Low Pressures," by J. N. Collie, Ph.D., F.R.S.

ATKINSON'S MEASURING INSTRUMENTS.

MESSRS. L. B. AND CLAUDE W. ATKINSON, of Cardiff, have recently placed their patent dead-beat ammeters and voltmeters upon the market. These instruments are already being employed by quite a large number of manufacturers and others throughout the country in connection with electric lighting and power installations, and we understand that they are being made in an English factory specially laid out for their manufacture. The parts are interchangeable, and every detail is stated to be the result of lengthy practical trials and experience. The special points claimed are their convenience, simplicity, and low cost. The moving part of the instruments is shown in fig. 1, and consists of a sealed glass tube containing a hydrometer or float carrying a soft iron wire, floating in a liquid. The float normally stands with the stem just out of the liquid, and the glass containing the tube is placed in the instrument so that the iron wire is just entered into a coil or solenoid. When a current passes in the coil the iron is drawn more or less into the coil by an amount which is a measure of the current. The indications are given by a band having black and white parts meeting, and the reading is taken at the junction. This band is the only part of the moving float that is visible when the tube is in the instrument. This arrangement is visible at a greater distance than the ordinary form of instrument pointer. The liquid in which the

float moves has a constant density at all temperatures, this being achieved by the use of a saturated solution of a special salt, of which a few crystals are left in the bottom of the tube, this salt having the property of dissolving or crystallising out in such proportion that by this action the change in density of the liquid by change of temperature is compensated for. The float fits the outer tube quite freely, but is kept from contact or capillary sticking by three glass points on the bulb, so that it floats centrally without touching; notwithstanding this, the magnifying effect of the outer glass and liquid makes the indicator appear of the full diameter of the outer tube. Special devices are adopted to allow the instrument to travel without breakage, and the percentage of instruments damaged in transit is practically nil, and greatly less than in the case of pivotted instruments. The outer cases of the instruments and the

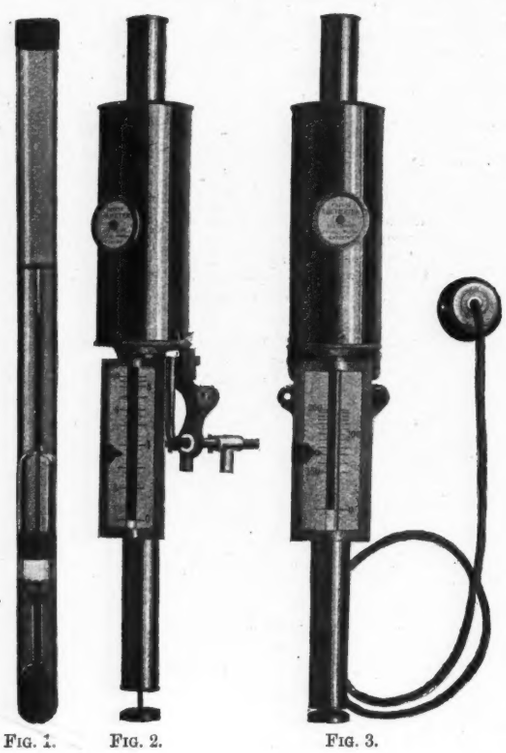


Fig. 1. Fig. 2. Fig. 3.

Fig. 1.—Moving Part of Patent Ammeters and Voltmeters.

Fig. 2.—Ammeter—Switchboard Type with Back Connections.

Fig. 3—Voltmeter with Flexible Wire.

coils are all made interchangeably by special tools and machinery. No material capable of aborbing moisture is used in the insulation or in the construction of the coils, terminal and leading-in wires are supported on porcelain insulators, and each instrument is calibrated independently. Fig. 2 shows the switchboard type of ammeter with back connections, and fig. 3 illustrates a continuous-current voltmeter with flexible wire. The advantages claimed for the new type of instrument are:—

1. Frictionless movement without use of costly and delicate jewelled pivots.
2. Dead-beat and damped movement, doing away with the troublesome oscillations of the indicator, which in some types make it difficult to read the instrument.
3. Unaffected by external magnetic fields.
4. Vertical scale easily read at a distance of many yards, with bold figures.
5. Adjustable indicator showing proper working point on scale.
6. Handsome appearance, polished brass throughout.
7. Low price, due to simplicity and system of manufacture.

The makers are now making the instruments in enamelled glass with the bottom part black. As the back of the brass tube is blacked into which the glass tube is slipped, when the float rises it appears as if there were a column of black fluid rising behind the scale. This makes the indication clearer than is the case with the paper index mounted in the float, as shown in the accompanying illustrations. We are informed that by keeping the amount of iron used small the hysteresis in the instruments is very low. The scales can be made to suit almost all requirements by opening the readings at the part mostly used on an installation, but as a rule the standard instruments are made with a fairly uniform scale to within about 70 per cent. of the maximum reading, and then closed, as it is found that—with motor work, for instance—customers prefer to have an open scale at the working loads of the motor with closed scale reading up to 30 per cent. overload. Messrs. Atkinson now make their voltmeters with a much more open scale than that shown in the illustrations, the scale extending throughout the same length on the dial, as in the case of the ammeters.

NOTES.

Preece's Wireless Telegraphy.—What the *Belfast News Letter* describes as a superior system to Marconi's was formally opened the other day for the commercial transmission of messages between Rathlin Island and the mainland. The system is Preece's well-known "electro-magnetic" system, which, however, more probably works by earth currents than by electro-magnetic waves. Though the distance is only about six miles, it has not yet been possible to generate sufficient current in the receiver to actuate a calling apparatus. Efforts are being made to utilise Lodge's telephonic magnifiers for this purpose. The currents in the transmitting circuit are interrupted 400 times per second by a small Cuttriss motor. Connected to receiver and to the transmitter there are two parallel wires in a vertical plane, the free ends of which dip into the sea. The Preece system is said to require less skilled attention than the Marconi system, and is not so liable to get out of order. Its first cost is, however, greater, and its maximum range is evidently much less.

Presentations.—On Sunday, the 2nd inst., Mr. Fredk. Black, the resident construction engineer to the Merthyr Electric Traction and Lighting Company, who was accompanied by Mrs. Black, was presented with a handsome silver mounted salad bowl, a set of dessert knives, and focussing hand camera. The presentation was made by Mr. A. K. Taylor, on behalf of the staff and men of the company, on the occasion of Mr. Black leaving the town on the completion of the construction work. Mr. and Mrs. Black, left for London a few days later, and were given an enthusiastic send off.

A presentation was made last week to Mr. J. F. Coates, assistant electrical engineer, on behalf of the employés at the Burnley electric lighting station, of a handsome writing desk, on his severing his connection with them, as a token of their appreciation and esteem. Mr. Coates goes to Farnworth.

On Wednesday last week the staff and employés of the Hammersmith Borough Council electricity works presented Mr. W. E. Brandreth, the late mains superintendent, with a case of drawing instruments and an illuminated address containing over 60 signatures, as a mark of esteem on the occasion of his leaving to take up the position of resident engineer and manager to the Wycombe Borough Electric Light and Power Company.

Course of Instruction.—At the University College of North Wales, at Bangor, a course of instruction in electrical measurement and practical electricity will be commenced. Particulars as to terms, cost of living and so forth, appear in our advertisement pages to-day.

Royal Society.—Yesterday, Thursday, the Bakerian Lecture was delivered by Prof. James Dewar, F.R.S.: "The Nadir of Temperature and Allied Problems";—

1. Physical Properties of Liquid and Solid Hydrogen.
2. Separation of Free Hydrogen and other Gases from Air.
3. Electric Resistance Thermometry at the Boiling Point of Hydrogen.
4. Experiments on the Liquefaction of Helium at the Melting Point of Hydrogen.
5. Pyro-Electricity, Phosphorescence, &c.

Boiler Tube Burst.—A tube in a water-tube boiler doing service on board the Admiralty ship *Daring*, burst on 10th inst., killing one stoker and injuring severely several others. In the House of Commons on the following day, when questions were asked relating to the affair, Mr. Arnold Forster said that it was a "Thorneycroft boiler of a peculiarly safe type" as used in hundreds of vessels.

Postal Telegraph Department.—Mr. C. A. Burge, assistant superintending engineer in the Midland District of Ireland, has been appointed superintending engineer in the North Wales District in succession to Mr. E. Ashton, retired.

American Competition in Electrical Engineering.—The Hon. R. P. Porter, commercial attaché for the United States, said some very trite things before the Chesterfield Chamber of Commerce on Tuesday in relation to American competition in industry. His remarks as to the comparative progress of electricity in England and America we quote as follows :—

The electrical industries have made greater progress in the United States because individual effort is allowed full play there, whereas in England Governmental and municipal interferences, and trading have soaked out the spirit of enterprise and turned over to the red-tape of officialdom stupendous undertakings which, in America, were conducted by the strongest and most capable of our captains of industry. It was in the new, not the old, industrial problems that England was weak. Let her cease destroying individual effort by laws which throttled enterprise and locked up millions of public funds in industries which would thrive far better under individual direction. In the one electrical field alone an immense capital could be employed, and if given a free hand, electricity, as light, heat, and motive power, would make a headway in the United Kingdom, relatively speaking, as great as it has done of recent years in the United States. The American user of machinery and plant gets much nearer, and relies to a greater degree upon the manufacturer and the practical experts with which he surrounds himself. "Bring the user and the manufacturer closer together" should be the watchword. When a firm has obtained a contract after fair competition, give it free headway to complete the work. Too many intermediaries, even though they are men of scientific training and high character, complicate rather than simplify the construction of larger mechanical undertakings. The Briton had the qualities of success with him, and held out well in the long race. The fact that he was willing to place the worst before him was an indication of strength rather than of weakness, provided he did not dwell too long upon the sombre side of the picture. Therefore he was not inclined to lay too great stress upon current statistics showing short periods of trade depression.

Berlin Visit of the I.E.E.—Those whose intend to take part in this tour, and unfortunately are not conversant with the German language, would do well to purchase a copy of "Colloquial German," by H. Swan (David Nutt, 57—59, Long Acre). While it is impossible to acquire a language by way of the eyes, this little handbook will at least afford some preparation for the peculiarities of German, and contains not only numerous useful phrases (with phonetic pronunciation), but also many valuable hints on points of German etiquette—a matter of so great importance, yet one which is so commonly ignored by the British tourist, to the extreme annoyance of his Continental would-be friends.

Electric Tramways and Observatories.—The *Rangoon Times* of May 16th says :—"The special committee of electrical experts appointed by the Government of Bengal to consider the effect of electric tramways on magnetic observatories report their inability to suggest rules that will protect observatories from disturbances where the overhead trolley system of electric traction is used, and recommend the removal of existing observatories, and that in future sites should be selected where there would be no chance of electric tramways being in the neighbourhood, 20 miles away being a safe distance."

Standardisation of Frequency.—The desirability of standardising the frequency of alternators becoming more and more apparent, Mr. T. Rudhardt, editor of the *Macchina*, of Geneva, has taken the initiative, and has addressed the following questions in this connection to the principal European factories:—(1) What is the frequency which you are most frequently asked for, and why? (2) What is the most usual frequency in your factory? (3) Would you be favourable to two fixed numbers of periods common to all manufacturers, and what would be those numbers? (4) Would you be favourable to a single frequency common to all manufacturers, and why? What would be, according to you, the most convenient frequency in this case?

Glasgow Electricity Supply.—In a letter to the *Glasgow Herald*, Mr. W. B. Sayers draws attention to the fact that by the change from 100 to 250 volts, the users of arc lamps are placed at a considerable disadvantage, as they must use five open arcs instead of two in series, or two enclosed arcs + a resistance in place of one; further, if only one lamp is wanted the whole circuit must be turned on, and to use even two lamps it might be necessary to light up 10. On this account Mr. Sayers advocates a reduced rate to users of arc lamps.

Picture Telegraphy.—Many attempts, more or less successful, have been made to transmit pictures through a telegraph line. Elisha Gray and others have used the writing telegraph to make facsimile drawings at a distance, and Sczepanik has devised an apparatus intended to enable us to actually see by telegraph, but this apparatus is complicated, and has not as yet been practically successful. Quite recently Herr Otto von Bronk has devised a simple and ingenious apparatus for printing at the receiver a photograph of any illuminated object placed in front of a lens at the transmitter. Herr von Bronk makes use of the wonderful susceptibility of steel wires to magnetic strain, utilised by Poulsen in his telegraphone. The image or the object is thrown by a photographic lens on a surface made up of a mosaic of selenium cells. Each cell is in circuit with one of a series of electro-magnets arranged so as to produce transverse magnetic strains in a ring of steel wire, each strain being, of course, proportional to the intensity of light acting on its corresponding selenium cell. These strains are reproduced on a similar ring at the receiving station by a synchronous rotating arm, just as a telegraphone record would be copied on to another wire moving at the same speed. By reversing the original operation, the magnetic copy of the picture is retranslated into an optical one, a photographic negative being produced. Further details with illustrations of this apparatus will be found in *Elektrotechnische Mitterlungen* I., p. 91.

Obituary.—It is our sad duty this week to record the death of Lord Wantage at the age of 69 years. His lordship was best known to the electrical world by his connection with the London Electric Supply Corporation, of which he has for many years been chairman. He was by far the largest shareholder in the company, and he stood by it year after year with the same confidence and determination which characterised his behaviour at the battles of Alma and Inkerman. Those who are anxious to read a full account of the splendid career of this Grand Old Man should see the *Times* for Tuesday, June 4th.

Electric Hoists on Warships.—In regard to the use of electric hoists on British warships, the *Daily Chronicle*, after remarking that the Admiralty have regarded them hitherto with repugnance, says :—"Now all this is changed. An order has just been issued for electric hoists to be fitted to all British warships that carry guns in casemates, that is to say, to the *Majestic* and *Diadem* classes, the *Powerfuls*, and probably the *Royal Sovereign* and *Edgar* classes also."

Board of Trade Proposed Tramway Regulations.—A correspondent states that the Board of Trade are proposing to make certain regulations with regard to electrical traction by the overhead system, and have addressed a circular letter of inquiry to local authorities in Surrey and Middlesex with a view to obtaining information as to local requirements in the matter.

Marriage.—The marriage of Mr. P. J. S. Tiddeman, electrical engineer, of St. Annes-on-the-Sea, formerly of Pontypool, with Miss Agnes Copley, of Pontypool, recently took place at the parish church, Trevethin.

Mr. J. G. McLean, engineer and manager of the Woking Electric Supply Company, was married on 4th inst. The staff and employés presented him with a cake basket and biscuit box.

Appointments Vacant.—A lecturer and demonstrator in electrical engineering is required for Hull Municipal Technical School at £150 per annum. A car shed superintendent is wanted for the Sheffield tramways at £150 per annum. The British Electric Traction Company is requiring the services of one or two gentlemen capable of negotiating with local authorities.

Manchester Trams.—Sir F. Bramwell has been appointed arbitrator in the arbitration between the Corporation and the Manchester Carriage Company, and has, with the representatives and witnesses of the two parties, inspected the 10 miles of track which have to be acquired from the company. The date of the inquiry, which will take place in London, has not yet been fixed.

Röntgen Rays and Electric Light Treatment.—The surgeon to the Röntgen Ray Department of the London Skin Hospital writes the following interesting letter to the *Times* :—

There have been many letters during the past months in the daily papers *re* the light treatment for lupus, rodent ulcer, &c. Now, while fully recognising the cures which have been effected by the electric light treatment, it may be of interest to your readers, and of benefit to many sufferers who cannot spare the time and money required by that treatment, to note that, at the London Skin Hospital, Fitzroy Square, the staff have been treating for the past year many cases of lupus, rodent ulcer, &c., with most excellent curative results, with the applications of the Röntgen rays. The action in both cases is very similar, but the Röntgen rays possess every advantage of the electric light treatment, with none of its disadvantages.

1. The Röntgen ray apparatus costs only about £100, compared with many times that cost for the electric light apparatus.
2. There is absolutely no pain or discomfort in the application, whereas the electric light treatment is by no means free from some discomfort and pain.
3. The time required for each application varies from 5 to 15 minutes, compared with from one to two hours required in the light treatment.
4. The number of applications needed to effect a cure in any given case is much fewer than that of the light treatment.
5. There is no need for any special nurse, and the surgeon can carry out the application single-handed, whereas the same is not possible in the case of the light treatment.

Boiler Explosion Inquiry.—On behalf of the Board of Trade Mr. Howard Smith opened an inquiry at Westminster on Monday, into the circumstances attending a boiler explosion which occurred last November at the Sardinia Street station of the Metropolitan Electric Supply Company, whereby a workman was killed. Mr. Gott, who appeared as counsel for the Board of Trade, said that the boiler in question was put into position in January, 1889, and was of the water-tube type. The boiler was periodically inspected by water-pressure test, every precaution with regard to the kind of water used was taken, but up to the time of the explosion, nothing was noted which indicated the presence of danger. The stipulated pressure was 175 lbs. to the square inch, but the working pressure was not above 160 lbs. In 1898 partial examinations were made as to the cleanliness of the boiler; in fact, it was partially cleaned upon six occasions in that year and thoroughly cleaned once. On May 11th, 1901, it was thoroughly cleaned again, and in June was inspected by the company's inspector, no fault being discovered. On the day of the explosion the pressure was 150 lbs. Subsequent examination showed that one of the tubes had fractured, the original thickness having been much lessened by corrosion. It would be for the inspector to ascertain precisely what the cause of the explosion was. An inquest on the victim was held by Mr. John Troutbeck, and a verdict of Accidental Death was returned. The plate thickness of the tubes was $\frac{3}{8}$ inch. Evidence was given by Mr. Kolle, London manager of Messrs. Babcock & Wilcox, who supplied the boiler, as to dimensions. All the tubes were tested at the highest pressure by the makers before being fitted up.

The Metric System.—In the House of Commons last week a question was raised by Mr. Labouchere in regard to the use of the metric system by British traders. In reply, Mr. Gerald Balfour said that reports from his Majesty's representatives abroad frequently allude to the impediment caused to British trade by the adherence of many of our traders to the usual British system of weights and measures in their transactions with countries in which metric standards are in use. He, however, pointed out that the Act of 1897 removed any legal impediment to the adoption of metric standards. The Government is not prepared to bring in a measure making the use of the system compulsory.

Visit of the Institution of Electrical Engineers to Germany.—We are informed that in the unavoidable absence of the president, Mr. Alexander Siemens (past president) will, at the unanimous request of the Council, assume the leadership of the Institution party throughout the visit to Germany. Members are reminded that their applications for tickets should be forwarded before Saturday, June 15th.

Personal.—Mr. L. Paton Greig, formerly of Edinburgh, has been appointed chief electrical engineer at the Bury St. Edmunds electric lighting works in succession to the late Mr. A. H. Roe. Mr. Greig was formerly assistant inspector of mains at Edinburgh, and after three years' service was appointed electrican-in-charge of an eight hours' shift at Bradford (Yorkshire). About 10 months ago he was appointed assistant electrical engineer at Bury St. Edmunds.

We understand that Mr. Fred. Bathurst, of the Conduit and Insulation Company, Limited, is sailing on the 15th inst., per ss. *St. Louis*, for a combined business and pleasure trip to the U.S.A. He will pay a visit to the Buffalo Exhibition, and specially study the electric wiring developments. We hope Mr. Bathurst will return fully restored to health and strength after his long indisposition.

Electric Fire Detection.—On Tuesday an exhibition of the May-Oatway electric fire detector was given at 13, St. John's Lane, Liverpool.

NEW COMPANIES REGISTERED.

Magnus Volk, Limited (70,378).—This company was registered on June 3rd, with a capital of £10,000 in £1 shares (5,000 preference), to acquire, undertake and work the electrical tramways on the beach in the Borough of Brighton, east of the west entrance of the Aquarium, now worked by Magnus Volk under the sanction of the Brighton Town Council, and any additions to and extensions of the said tramway, to carry on the business of tramway proprietors, electrical and general engineers, &c., and to adopt an agreement with Magnus Volk. The first subscribers (each with one share) are:—F. A. Gill, 29, Sudeley Street, Brighton, book-keeper; L. Farncombe, 29, Sudeley Street, Brighton, stationer; W. Grutchfield, 18, Prestonville Terrace, Brighton, accountant; J. Smithers, 4, Bates Road, Preston, Brighton, railway inspector; F. Hilton, 4, Pavilion Buildings, Brighton, accountant; Mrs. A. Volk, 17, Clermont Terrace, Preston; and Magnus H. Volk, 17, Clermont Terrace, Preston, electrical engineer. No initial public issue. The first directors are Magnus Volk, Magnus H. Volk, and Walter Grutchfield.

Article Club Company, Limited. — Registered on June 6th by C. U. Fisher, 19—20, Holborn Viaduct, E.C., with a capital of £25 in £1 shares. Objects: To take over the business of the unincorporated association known as the Article Club. No initial public issue. The first directors are Lord Suffield, J. Dixon, and L. Cowen. Registered office, St. Irmin's Hotel, Westminster, S.W.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Northampton Electric Light and Power Company, Limited (28,640).—Particulars of registered mortgages and charges. Total amount secured by series of debentures created by resolutions dated December 6th, 1898, and March 8th, 1901, £8,600. Amount of debenture issue made March 8th, 1901; £5,000 in one debenture of £5,000. Date of registration, March 27th, 1901. Total amount secured by series of debentures created by resolution dated June 3rd, 1896, "Not more than two-thirds of the subscribed and paid-up capital for the time being of the company." Amount of debenture issue made April 15th, 1901, £700 in 14 debentures of £50 each. Date of registration, April 25th, 1901. Property charged (both series). The undertaking and property of the company, present and future, including uncalled capital. No trustees for either series.

Northampton Electric Light and Power Company, Limited (28,640).—This company's annual return was filed on March 26th, when 10 "A," and 36,922 "B" shares were taken up out of a nominal capital of £50,000 in 10 "A," and 48,990 "B" shares of £1 each. £1 per share has been called up, resulting in the receipt of £36,932. Mortgages and charges, £28,400. Since the date of the return, 900 "B" shares have been allotted.

Brush Electrical Engineering Company, Limited (29,533).—This company's annual return was filed on May 8th, when 105,731 ordinary and 113,374 preference shares were taken up out of a nominal capital of £660,000 in 180,000 ordinary and 150,000 preference shares of £2 each. £2 has been called up on each of 35,817 ordinary and £41,837 preference shares, resulting in the receipt of £155,003 2s. 5d. £304 17s. 7d. remains in arrears. £282,902 is considered as paid on 69,914 ordinary, and 71,537 prererence. Mortgages and charges, £250,000.

Brush Electrical Engineering Company, Limited (29,533).—Particulars of registered mortgages and charges. Date of creation of mortgage or charge, April 15th, 1901. Total amount secured, £25,000 and interest. Property charged, allotment monies and other monies payable in respect of 12,500 preference shares to be issued. Mortgagees or persons entitled to charge, Parr's Bank, Limited. Date of registration, April 24th, 1901.

CITY NOTES.

Telegraph Manufacturing Company, Limited.

The ordinary general meeting took place on Friday last week at Liverpool. Mr. James Taylor presided

The Chairman said it was a pleasure to the directors to meet the shareholders, although the profit and loss account did not show the same profit as last year. Last year the company made a profit of £41,000 odd, this year they had made a profit of £35,183. That had been caused by two things. The first was that last year they had a good contract in hand which was taken by the old company, and the new company had certainly got the benefit of it. Then, in the second place, the past year had been one of great difficulty in the making of the goods. During that time they had practically reorganised the whole of the factory. Where they used to drive by steam engines they now drove by electric power, with the result that a great portion of the machinery had had to be altered. It had disorganised them to a large extent, and had made the directors feel that when large contracts were offered they dare not undertake them if they were to be under heavy penalties for non-delivery up to time. They thought it best to get the works into working order before contracting for such work. He (the chairman) was now very glad to tell the shareholders they were in a position to contract for some of the large orders which were being given out by large corporations. They would see that their property had been increased by the sum of £16,374, but they hoped that the heavy capital expenditure which they had had for the last three years was now at an end. There were still some little things to do so far as their Helsby works were concerned. He would like to point out that the actual amount paid for that business three years ago was £47,000, and their reserve fund now stood at £55,000, which he was sure must be satisfactory to everyone. There was one other thing he would like to touch upon. They saw that the telephone business was likely to become of very great importance. Since they last met several towns had gone in for that, and they (the directors) had gone in for it, and were making a speciality of big central switchboards, and they were in the very unique position of having secured the only two orders for town exchange telephone-boards which had been given out during the year. In their present works they could not get through more work than they had in hand, so they were negotiating for land upon which to erect a proper factory. By next year he hoped he would be able to tell them they had one of the best equipped factories for that class of work in Great Britain. He begged to move that the report be adopted, and that a dividend of 12 per cent. per annum for the half-year (6s. per share) and a bonus of 2 per cent. (2s. per share), being in all at the rate of 12 per cent. for the year, be paid, and that the balance of £7,661 5s. 11d. be carried forward.

Mr. Harmood Banner seconded.

Mr. James Smethurst said that in the balance-sheet it was shown that there was a reserve fund of £55,000. He would like to ask what that was invested in, and what interest it was bringing in?

The Chairman replied that the reserve fund with them was as it was with other industrial companies. It was invested in the business. If they would turn to the balance-sheet, they would see the large amount invested in buildings and stock-in-trade. If the reserve were invested in outside securities it would be necessary to increase the capital.

The report and statement of accounts were adopted.

Mr. George Nicholson was elected an auditor on the proposition of Mr. G. H. F. Robertson, seconded by Mr. J. Shaw.

A vote of thanks to the chairman for presiding was proposed by Mr. Harmood Banner and seconded by Mr. Smethurst. This was unanimously passed and the business closed.

The Metropolitan District Railway and Electric Traction.

A special meeting of shareholders of the Metropolitan District Railway Company was held on 6th inst., at the Westminster Palace Hotel, to consider the Bill now pending in Parliament to empower the company to adapt their railway to electric traction, and also an agreement between the company and the Metropolitan District Electric Traction Company. We abstract the following from the *Times* report:—

Mr. J. S. Forbes presided, and explained the changes it was proposed to make in the Bill and the terms of the agreement with the Electric Traction Company. The electrification of the railway was said to be the remedy for the evils under which they were suffering; but with their credit, how were they to make the change? The directors determined some time since, in view of the importance and the gravity of the position, to take the bull by the horns, and by some means to raise enough money to do it. They acted at that time on the principle that it was indispensable to the future of the undertaking that the money should be obtained, in order to enable them to adopt electric traction. The debenture holders, however, did not like having capital placed over their heads, nor did the preference shareholders desire their position to be altered by reducing their interest; but the ordinary stockholder, who was the master of the position, had to be conciliated. In the result it had been determined to abandon the financial proposals as formerly submitted to the proprietors, and the position of the debenture and preference stockholders was not to be altered. The Bill, however, had to be presented for confirmation in its original form, and this involved the process called "additional provision," which meant that Parliament would be asked to waive the provisions of the measure as it was at first introduced, and to allow the company to make the changes that had since been decided on. Since the Bill was first designed, a good many things had happened, and gentlemen of reputation, acknowledged ability, and with financial means, had been found who had come forward to assist the company. They began by buying up such an enormous percentage of the ordinary share capital, that they practically became masters of the position. They were very bold people, but he supposed that they would not have gone into this business if they had not understood it; and they had not only become partners with the company to a considerable extent—to the extent, perhaps, of half the ordinary capital—but they were willing to find further money to effect what the proprietors might in their own way have effected if they could have found the money themselves. He had no doubt that the Parliamentary Committee would consent to the abandonment of the clauses which it had been decided to strike out of the Bill, and that they would adopt the amended proposals by the petition for additional provision. The directors had remodelled the Bill in the additional provision. The matter was now all centred in the agreement between the railway company and the traction company, and on the part of the directors he advised the proprietors to confirm the proposed arrangements as a solution of the difficulties of the company. The parties referred to, having acquired the large holding of stock mentioned, were so confident in their power to raise that capital out of the mud into something good that they would find the other money that was necessary. This was the essence of the agreement, and the agreement was the crux of the question. It had been the subject of mature deliberation; it divided itself into two parts, one being the generating station and the other the conversion of the railway "from its present state of desolate waste of darkness into a brilliant galaxy of light." The generating station they propose to provide under one contract. It was to be erected by the parties in question, who would select firms to do particular kinds of the work, the object being to carry out the whole at the lowest cost, and the railway company were to have a voice in determining what was cost price. These gentlemen would not make any profit at all out of the generating station, which, on the completion of the works, would be hired to the railway company. The contract for the electrification and equipment for working the line by electric power differed from that in relation to the generating station. Mr. Yerkes's combination would take for that purpose all that the company had to give, and what they had to give was embodied in what the proprietors authorised the directors to do at a previous meeting. They had power to raise £500,000 of ordinary stock, which carried with it the power of creating £166,000 of 4 per cent. debenture stock. They had agreed to take the £500,000 ordinary stock at the nominal price of 25 per cent. and the £166,000 of debenture stock at par, and in virtue of that surrender they would take upon themselves the obligation of the conversion of the line. They undertook to carry out the change without any interference with the working traffic—an astonishing assertion of confidence. The parties were to find the money for the generating station and any other capital that might be necessary at 5 per cent. There was to be a 5 per cent. charge in the nature of a rental on the generating station, and 5 per cent. on any money required over and above the £500,000 ordinary stock and £166,000 debenture stock referred to. The board had enough proxies to carry anything, but what they wanted to see was the resolution agreed to unanimously by the proprietors present. The Electric Traction Company was at present an inchoate body, but the company would be formed with a sufficient capital, and with a margin much more than sufficient to fulfil all the obligations undertaken. The company, indeed, was so far formed that he had received from their friends the names of a combination of first-class bankers and others in America who would "table the sovereigns" as security for carrying out the contract.

Major L. H. Isaacs seconded the resolution.

Mr. Perks, M.P., thought that the chairman had made the position quite clear. He himself had not a penny of interest, professional or other, in the new company which was to undertake the arrangements for the electrification of the railway. The arrangements between the Traction Company and the railway company provided for the absolute subscription of 1 million sterling by responsible people before the agreement was exchanged; and already that company had its memorandum and articles of association signed by at least 16 names, including some of the wealthiest firms in America. It was not, however, wholly an American group, some well-known Englishmen being connected with the enterprise. He did not think that they ought to feel any antipathy to Americans investing in railways here. The English sent a great deal of their money to America in the early history of railways there, and now this attention was being reciprocated. Moreover, the British investor did not altogether like to invest in electrical railways, as he did not appreciate such undertakings as the Americans did. He desired to emphasise the fact that the Traction Company would not make a penny of profit either on the erection of the power-house or on the supply of the materials for the electrification of the railway. Those who were supplying the money which was required to carry

out the proposed changes looked to the future increment in the value of their stock for their remuneration. The agreement would be ready for exchange immediately it was sealed by the two companies. Parliamentary sanction would be given to it on that basis, and before the company's Bill proceeded through certain stages in the House it would be necessary to produce the agreement with the seals of this company and of the Traction Company to it. He was very anxious in connection with their electrical arrangements that nothing should be done to bring them into conflict with the Metropolitan Company.

The Chairman stated that the directors were assured that £400,000 was a liberal estimate for the cost of the generating station. By the conversion of the line to electric traction, according to what he had been told, more trains could be run, and at a much less average cost per train-mile than at present. The District Company now spent 52 per cent. of their receipts in expenses, whereas it was said that electric lines could be worked at 35 per cent. The difference between those two rates would represent £70,000 to this company. There would be an enormous saving, however, if the working expenses were 40 or even 45 per cent.; and, in addition, there was the multiplication of trains.

The motion was carried unanimously.

Stock Exchange Notices.—The Committee have (1) appointed special settling days as under:—Wednesday, June 19th, West London and Provincial Electric Supply Company, Limited—9,891 ordinary shares of £1 each, fully paid, Nos. 7,501 to 11,425, 12,926 to 15,025, and 16,026 to 19,891, and 34,314 6 per cent. cumulative preference shares of £1 each, fully paid, Nos. 7,501 to 36,045 and 36,146 to 41,914; (2) and ordered the undermentioned securities to be quoted in the Official List:—Edmundson's Electricity Corporation, Limited, 6,637 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 6,637.

New Issue.—The directors of the Bristol Tramways and Carriage Company, having decided to issue the further 25,000 4 per cent. cumulative preference shares created at the last general meeting of shareholders, have given to registered holders only of the company's debenture stock, preference and ordinary shares the privilege of applying for the new shares at par. Applications were to be made through the company's bankers, Lloyds Bank, Limited, Bristol, before to-day.

Drake & Gorham, Limited.—The letters of allotment for the total amount of the capital recently offered to the public by Drake & Gorham, Limited, have now all been posted.

Commercial Cable Company.—The directors have declared a quarterly dividend of 1¾ per cent.

TRAFFIC RECEIPTS.

Blackburn Corporation Tramways.—The receipts for the week ending June 7th were £510; corresponding week last year, £752; decrease, £242. Total to date, £10,542; corresponding period last year, £9,591; increase, £951. Miles of track open, 8¾.

Blackpool and Fleetwood Tramways.—The receipts for the week ending June 8th were £878; corresponding week last year, £1,834; decrease, £956. Total to date, £7,871; corresponding period last year, £7,729; increase, £142.

Bristol Tramways and Carriage Company.—The receipts for the week ending June 7th were £4,406; corresponding period last year (Whit week), £4,708; decrease, £302.

Central London Railway.—The receipts for the week ending June 8th were £6,063; previous week, £6,368; decrease, £305. Total receipts to date (23 weeks), £142,531. Miles open, 6.

City and South London Railway.—The receipts for the week ending June 9th were £1,922; corresponding week last year, £1,591; increase (Clapham extension open) £421. Total to date, £45,208; corresponding period last year, £29,255; increase, £15,953. Miles open, 1901, 4½; 1900, 4½.

Dover Corporation Tramways.—The receipts for the week ending June 8th were £221 5s. 6d.; corresponding week last year, £270 4s. 2d.; decrease, £49 9s. 8d. Total to date, £4,170 15s. 1½d.; corresponding period last year, £3,851 18s. 1½d.; increase, £312 16s. 11d. Miles of track open, 3; Car miles run, 1901, 5,114; 1900, 5,021. Number of cars, 11.

Dublin United Tramways Company.—The receipts for the week ending June 7th were as follows:—D. U. T. Co., electric cars, £3,819 13s. 7d.; D. S. D. Co., electric cars, £927 10s. 4d.; total £4,747 3s. 11d.; corresponding week last year—D. U. T. Co., electric cars, £4,276 0s. 10d.; ditto, horse cars, £77 3s. 5d.; D. S. D. Co., electric cars, £1,254 16s. 7d.; total, £5,608 0s. 10d.; decrease, £860 16s. 11d.; aggregate to date, £93,225 15s. 7d.; aggregate to date last year, £93,957 2s. 3d.; decrease, £731 6s. 8d. The mileage worked is 45 miles electrically, as against 42 miles electrically, and 2 miles by horses, for the corresponding period last year. 1900, Whitsuntide.

Liverpool Overhead Railway.—The receipts for the week ending June 9th were £1,651; corresponding week last year, £1,781; decrease, £130. 1900 includes Bank Holiday. Total to date, £36,106; corresponding period last year, £32,790; increase, £3,316. Miles open, 6 miles 57 chains.

STOCKS AND SHARES.

Wednesday Evening.

The Stock Exchange is settling down to a more normal state of affairs now that the money market has grown easier. Nor is the political outlook more clouded than usual, and as to the South African war, it has been with us, like the poor, for so long, that the markets have ceased to pay it any particular heed. The internal trouble which menaced the Yankee railroad department is all but over, and there is a fair amount of general business going on, despite the commencement of racing, and the temptations afforded by the fine weather for neglecting work, which always appeal with peculiar force to the Stock Exchange mind.

Electrical sections, however, have so far failed to benefit by the rather improved tendency that is general in other markets of the House. The declines outnumber the rises in each department, but these are mainly immaterial, and in most cases merely the result of settlement, before the advent of which prices are prone to droop This week they have not had time to recover before these notes are in type. The Supply Companies maintain their firmness of last week, with only three exceptions, but the Telegraph and Telephone securities are duller, and the manufacturing department is also a shade easier.

Central London Ordinary (Undivided) shares are ¼ down, partly on the idea that the electrification of the Metropolitan and the District Railways must rob the C. L. Railway of some of the traffic which it diverted from its neighbours' lines. Like many other Stock Exchange alarms, the fear appears to be purely chimerical. As regards Metropolitan District, the stock has fallen to 30 again on the amplification of details respecting the line's electrification. The company, by the way, is now empowered to subscribe and hold shares for any sum not exceeding £200,000 towards the capital of the Brompton and Piccadilly Circus Railway. These securities are at present unmarketable.

Both City and South London shares and Waterloo and City Ordinary stock have fallen slightly during the week, even as they both advanced the same amount in the preceding week. But not all the electric traction specialities are dull. London United Debentures are better at 105, despite the opposition to an extension of the company's lines which is threatened by the London County Council and the Middlesex County Council. Probably the stockholders are aware of the happy knack the London United Tramways Company has in getting its own way in the long run. British Electric Traction shares are unchanged at 15, but British Columbia Electric Railway Preference are being sought for, and have risen to 9⅜, rather buyers. Buenos Ayres and Belgrano Ordinary have been done at 1⅝, the "A" Preference at 5$\frac{5}{16}$, and the "B" Preference at 5¼.

The Motor Traction Company, shares in which are unsaleable, has brought its debit balance up to £7,139 by the addition of £1,316 loss during the past year. It will be remembered that the Motor Traction sprang from the London Steam Omnibus, which was a failure. The company's business has been virtually suspended for some time, consequent upon the construction of a factory, but the days of difficulty should soon be past, and the patient shareholders will await coming events with eager anxiety.

In the electric supply market, Chelsea Ordinary and Edmundson's Preference have both declined ¼. We understand that the underwriting letters for the latter company's baby—the Urban—are now out. Metropolitans are ½ lower, a natural reaction after their recent series of rises. City of London Preference redeem the list from monotonous weakness by having improved 10s. upon a good revenue statement for the March quarter, while Kensington Debenture is harder by the widening of the quotation only. London Electric Supply shares suffered no change upon the news of the lamented death of Lord Wantage, V.C., the chairman of the company.

Telegraph stocks and shares are lower where any change is recordable at all. The Anglo-American group has formed a favourite selling ground during the last day or two. For one thing an all-French cable system is being talked about, and, moreover, a Stock Exchange report gained currency to the effect that the company is feeling the competition of the Commercial Cable undertaking, the latter having also opened a new office in Shorter's Court. This last rumour has been denied by the secretary of the Anglo Company. Commercial Cable stock rests at $180, and the Debenture stock has gained a point at 102. In the Eastern division "Chinas" are minus the 5s. rise that they scored last week, but otherwise this group shows practically no alteration. Cuba Telegraph Preference are flat at 15, but the Ordinary maintain their nominal quotation.

National Telephones appear to be on their way to £3 once more, a good many shareholders having taken advantage of the recent rise to clear out or to reduce their investment in this company. Chadburn's (Ship) Telegraph shares are rather harder at 1 for both Ordinary and Preference, the report proving satisfactory. Welsbach descriptions are weak at the formation of a trust for testing in the Courts the validity of the Welsbach patent of 1893. The township of Durban, Natal, has been inviting subscriptions to a new 4 per cent. loan which is required for the acquisition and electrification of the present horse tramways, and the stock looks cheap at par.

SHARE LIST OF ELECTRICAL COMPANIES.—TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotations June 5th.	Closing Quotation June 12th.	Business done during week ended June 13th, 1901. Highest.	Lowest
96,900	African Direct Telegraph, 4 % Debs	100	...	...	...	100 —103	100 —103	...	...
119,700*l*	Amazon Telegraph 5 % Debs., Nos. 1 to 1,250 Red. ...	100	...	...	...	78 — 83	78 — 83	...	...
822,700*l*	Anglo-American Telegraph	Stock	£3 9s.	73/6	3½%	54 — 57	54 — 57	...	...
3,088,540*l*	Do. do. 6 % Pref	Stock	6 %	6 %	6 %	98 —100	97 — 99	99	97½
3,088,540*l*	Do. do. Deferred	Stock	18s. %	£1 7s.	5s. %	10½ — 11	10 — 10½	...	...
44,000	Chili Telephone, Nos. 1 to 44,000	5	3 %	4 %	...	3½ — 4	3½ — 4	...	...
13,333,300$	Commercial Cable	$100	8 %	8 %	...	175 —185	175 —185	...	...
1,589,496*l*	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	...	...	...	100 —102	101 —103	102½	101¾
16,000	Cuba Telegraph	10	8 %	7 %	...	7 — 8	7 — 8	...	...
6,000	Do. 10 % Pref.	10	10 %	...	...	15 — 16	14½ — 15½	...	...
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	3 — 4	3 — 4	...	...
6,000	Do. do. 10 % Cum. Pref.	5	...	...	...	9 — 10	9 — 10	...	...
30,000*l*	Do. do. 4½ % Debs.	50	...	...	...	100 — 104%	100 —104%	...	...
60,710*l*	Direct United States Cable	20	3½%	3 %	3 %	10¼— 10¾	10¼— 10¾	...	...
108,300*l*	Direct West India Cable, 4½ % Reg. Deb.	100	...	...	...	100 —103	100 —103	...	...
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	...	140 —145	140 —145	143	141½
1,826,888	Do. 3½ % Pref. Stock	100	...	...	...	91 — 94	90 — 93	92¾	91
1,432,268*l*	Do. 4 % Mort. Deb. Stock Red.	Stock	...	...	...	110 —114	110 —114	112	110½
300,000	Eastern Extension, Australasia, and China Telegraph ...	10	7 %	7 %	7 %	13¾— 14½	13½— 14	13 1/16	13⅞
320,000*l*	Do. 4 % Deb. Stock	Stock	...	...	...	111 —116	111 —116	...	...
300,000*l*	Eastern and South African Telegraph, 4 % Mort. Deb. Nos. 1 to 3,000, red. 1909	100	...	...	...	100 —103	100 —103	...	...
200,000*l*	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1—8,000	25	...	...	...	100 —103	100 —103%	...	...
180,227	Globe Telegraph and Trust	10	5½%	5½%	...	9¾— 10¼	9¾— 10¼	10 1/16	9¾
180,042	Do. do. 6 % Pref.	10	6 %	...	...	14¾— 15½	14¾— 15½	14¾	...
150,000	Great Northern Telegraph, of Copenhagen	10	12½%	...	15 %	31 — 33	31 — 33	...	...
82,000*l*	Halifax and Bermuda Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	...	...	...	100 —103	100 —103	...	...
17,000	Indo-European Telegraph	25	10 %	10 %	10 %	43 — 47	43 — 47	...	...
100,000*l*	London Platino-Brazilian Telegraph, 6 % Debs.	100	...	...	...	103 —106	103 —106	...	...
72,680	Montevideo Telephone, Limited, Ord., Nos. 1 to 72,680 ...	1	...	2½%	...	¼— ½	¼— ½	...	...
86,492	Do. do. do. 5 % Pref., Nos. 1 to 86,492	1	4 %	5 %	...	¾— 1	¾— 1	...	...
590,000	National Telephone, 1 to 590,000	5	6 %	5 %	5 %	3⅜— 3⅝	3¼— 3½	3⅜	3 5/16
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	11½ — 12½	11½ — 12½	12⅜	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	11½ — 12½	11½ — 12½	...	...
250,000	Do. 5 % Non-cum. 3rd Pref., 1 to 250,000	5	5 %	5 %	5 %	4¼— 4½	4¼— 4½	4½	...
2,000,000*l*	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	87 — 90	87 — 90	89	...
500,000*l*	Do. 4 % Deb. Stock Red.	100	...	...	4 %	95 — 98	95 — 98	...	...
171,504	Oriental Telephone and Elec., Nos. 1 to 171,504, fully paid	1	5 %	5 %	6 %	⅞ — 1	⅞— 1	...	...
100,000*l*	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000 ...	100	...	...	...	100 —103	100 —103	...	...
11,839	Reuter's	8	5 %	5 %	5 %	7 — 8 xd	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	125 —130	125 —130	...	...
58,000	United River Plate Telephone	5	6 %	7 %	...	5 — 5½	5 — 5½	...	...
40,000	Do. do. 5 % Cum. pref. Nos. 1—40,000	5	...	...	...	4¾— 5¼	4¾— 5¼	...	...
179,947*l*	Do. do. 5 % Debs.	Stock	...	...	...	103 —106	103 —106	104	...
171,000	West African Telegraph, 5 % Debs....	100	...	...	...	98 —101	98 —101	...	...
30,008	West Coast of America, Nos. 1—30,000 and 53,001—53,008	2½	...	...	...	¼— ⅜	¼— ⅜	¼	...
150,000*l*	Do. do. 4 % Debs., 1—1,500 gua. by Braz. Sub. Tel.	100	...	...	...	100 —103	100 —103	...	...
207,930	Western Telegraph, Ltd., Nos. 1—207,930	10	7 %	7 %	...	13¾— 14¼	13¾—14¼	14	13 13/16
75,000*l*	Do do. 5 % Debs. 2nd series, 1906 ...	100	...	...	...	102 —105	102 —105	...	...
348,777*l*	Do. do. 4 % Deb. Stock Red.	100	...	...	...	102 —105	102 —105	...	...
88,321	West India and Panama Telegraph	10	2 %	5%	...	⅜— ⅝	⅜— ⅝	...	...
34,563	Do. do. do. 6 % Cum. 1st Pref. ...	10	...	...	...	5 — 6	5 — 6	...	...
4,669	Do. do. do. 6 % Cum. 2nd Pref. ...	10	...	...	...	3 — 5	3 — 5	5⅛	...
80,000*l*	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	...	...	...	103 —106	103 —106	5⅛	5

ELECTRICITY SUPPLY COMPANIES.

19,661	Brompton & Kensington Elec. Lt. Sup., Ord., 101 to 19,761	5	6 %	6 %	6 %	7¾— 8¼	7¾— 8¼	8	...
12,000	Do. do. 7 % Cum. Pref....	5	...	...	...	8¾— 9	8¾— 9	...	...
50,000	Charing Cross and Strand Electricity Supply	5	8 %	9 %	9 %	9 — 10	9 — 10	9½	...
20,000	Do. do. do. do. 4½% Cum. Pref.	5	...	...	...	5¼— 5¾	5¼— 5¾	..	...
34,000	*Chelsea Electricity Supply, Ord.	5	6 %	6 %	5½%	6 — 6½	5¾— 6¼	6	...
150,000*l*	Do. do. do. % Deb. Stock Red. ...	Stock	...	...	...	109 —112	109 —112	...	...
70,579	City of London Electric Lighting, Ord. 40,001—110,579...	10	6 %	4 %	0 %	8¾— 9½	8¾— 9½	...	...
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	12 — 13	12½ — 13½	...	...
400,000*l*	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	122 —127	122 —127	...	...
40,000	County of Lond. & Brush Prov. Elec. Ltg., Ord. 1—40,000	10	*nil*	4 %	4 %	8¾— 9½	8¾— 9½	...	...
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	6 %	6 %	6 %	11½— 12½	11½— 12½	...	...
200,000*l*	Do. 4½ % Deb. Stock, Prov. Certs (all paid) Rd. ...	...	...	...	...	105 —108	105 —108	...	...
35,000	Edmundson's Elec. Corp., Ord. Shares	5	6 %	6 %	...	5¼— 5⅝	5¼— 5⅝	...	...
20,000	Do. do. 6 % Cum. Pref.	...	...	...	...	5¾— 6	5¼— 5⅝	5 5/16	...
120,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock. ...	100	...	...	...	104 —107	104 —107	...	...
21,000	Kensington and Knightsbridge Electric, Ord.	5	...	...	...	11¼— 12½	11¼— 12½	...	...
90,000	Do. do. do. 4 % Deb. Stock	Stock	...	...	...	102 — 104	102 —105	...	...
110,000	London Electric Supply Corporation, Limited, Ord. ...	3	...	...	...	1¼— 1⅝	1¼— 1⅝	...	...
49,840	Do. do. do. do. 6 % Pref.	5	6 %	...	...	4 — 5	4 — 5	...	...
250,000*l*	Do. do. do. 4% 1st Mt. Db. Stock Rd.	Stock	...	...	...	98 —101	98 —101	...	...
85,000	Metropolitan Electric Supply, 101 to 62,500	10	5 %	5 %	6 %	14 — 15	13½ — 14½	14¼	14
220,000*l*	Do. 4½% First Mortgage Debenture Stock	...	...	...	...	110 —113	110 —113	...	...
250,000*l*	Do. 3½% Mort. Deb. Stock Red.	Stock	...	...	...	96 — 99	96 — 99	...	...
6,452	Notting Hill Electric Lighting	10	6 %	7 %	7 %	15½— 16½	15½— 16½	...	...
40,000	St. James's and Pall Mall Electric Light, Ord.	5	14½%	14½%	14½%	15 — 16	15 — 16	15⅝	...
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8½— 9½	8½— 9½	...	...
150,000*l*	Do. do. 3½ % Deb. Stock Red. ...	100	...	...	...	98 —101	98 —101	...	...
12,000	Smithfield Market Elect. Supply, Ord.	5	...	...	...	2 — 2½	2 — 2½	...	...
50,000*l*	Do. do. 4 % Deb.	100	...	...	...	80 — 90	80 — 90	...	...
65,000	South London Electricity Supply, Ord.	5	...	...	...	2½— 3½	2½— 3½	...	...
79,900	Westminster Electric Supply, Ord., 101 to 80,000... ...	5	12 %	13 %	10½%	12 — 13	12 — 13	12⅝	12½

* Subject to Founders Shares.
Unless otherwise stated all shares are fully paid.
Dividends marked ‡ are for a year consisting of the latter part of one year and the first part of the next.

Quotations on Liverpool Stock Exchange.
‡ Dividends paid in deferred share warrants, profits being used as capital.

SHARE LIST OF ELECTRICAL COMPANIES.—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL COMPANIES.

Present Issue.	NAME.	Stock or Share.	Dividends for the last three years. 1898.	1899.	1900.	Closing Quotation June 5th.	Closing Quotation June 12th.	Business done week ended June 12th, 1901. Highest	Lowest
		‡							
20,000	British Aluminium 7 % Cum. Pref.	10	...	...	...	7½— 8½	7½— 8½	...	...
300,000*l*	Do. do. 5 % 1st Mort. Deb. Stock Red. ...	Stock	...	...	...	85 — 93	89 — 93	92	91¼
45,000	British Electric Traction	10	6 %	...	...	14½— 15½	14½— 15½	15½	14¾
50,000	Do. do. 6 % Cum. Pref.	10	...	...	...	12 — 13	12 — 13	12½	12⅜
350,000*l*	Do. do. 5 % Perpetual Debenture Stock ...	Stock	...	...	...	120 —123	120 —123	121¾	121½
70,000	British Insulated Wire Ord.	5	15 %	20 %	15 %	10 — 11	9½— 10½	...	...
70,000	Do. do. 6 % Cum. Pref.	5	...	...	...	5⅝— 6¼	5⅝— 6¼	...	...
90,000	Brush Elecl. Enging., Ord., 1 to 90,000	2	5 %	6 %	...	1⅝— 1⅞	1⅝— 1⅞	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000 ...	2	6 %	6 %	...	2⅛— 2⅜	2⅛— 2⅜	...	...
125,000*l*	Do. do. 4½ % Perp. Deb. Stock	Stock	...	...	...	103 —108	103 —108	2 5/16	2¼
108,710*l*	Do. do. 4½ % Perp. 2nd Deb. Stock ...	Stock	...	...	...	101 —104	101 —104	102½	...
30,000	Callender's Cable Construction shares, Nos. 1—30,000 ...	5	15 %	15 %	15 %	14½— 15	14 —15	15 1/16	14⅛
40,000	Do. do. 5 % Cum. Pref.	5	...	...	...	5½— 6	5½— 6	5 13/16	...
90,000*l*	Do. do. 4½ % 1st Mort. Deb. Stock Red ...	Stock	...	...	...	109 —113	109 —113	...	...
206,297	Central London Railway, Ord. Shares	10	...	...	...	9½— 10	9½— 9¾	9⅝	9½
78,703	Do. do. Pref. half-shares	5	...	...	...	4½— 5	4½— 5	5	...
78,703	Do. do. Def. do.	5	...	...	...	4¾— 5⅛	4¾— 5⅛	4¾	...
855,000	City and South London Railway	Stock	2⅛%	1⅞%	1½%	51 — 53	51 — 53	...	...
37,500	Do. do. Ord. shares Nos. 22,501 to 60,000	10	...	...	...	5 — 5½	4¾— 5⅛	...	...
54,000	Crompton & Co., Nos. 1 to 54,000	3	6 %	7½%	...	3½— 4	3½— 4	...	...
100,000*l*	Do. 5 % 1st Mort. Reg. Debs., 1 to 900 of £100, and 901 to 11,000 of £50 red	...	...	...	...	101 —104	101 —104	...	...
99,261	Edison & Swan Utd. El. Lgt., "A" shares, £3 pd. 1 to 99,261	5	6 %	6 %	...	1 — 1½	1 — 1½	...	...
17,139	Do. do. do. "A" Shares, 01—017,139 ...	5	6 %	6 %	...	2½— 3½	2 — 3	...	...
344,023*l*	Do. do. do. 4 % Deb. Stock Red ...	100	...	...	...	87 — 89	87 — 89	...	...
100,000*l*	Do. do. 5% 2nd Deb. Stock Prov. Certs. all pd.	100	...	...	...	94 — 98	94 — 98	...	...
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	...	1⅜— 2¼	1⅜— 2¼	...	...
25,000	Do. do. 7 % Cum. Pref., 1 to 25,000... ...	2	7 %	...	...	2½— 3	2½— 3	...	...
182,500*l*	Do. do. 4 % Perp. 1st Mort. Deb. Stock ...	Stock	...	...	...	101 —104	100 —103	102⅜	...
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	14 %	15 %	20 %	15½— 16½	15½— 16½	...	...
35,000	Do. do. do. 4½ % Pref.	5	...	4½%	4½%	5½— 6	5½— 6	...	...
50,000*l*	Do. do. do. 4½ Mort. Deb. Stock...	Stock	...	...	...	107 —111	107 —111	...	...
50,000	India-Rubber, Gutta-Percha and Telegraph Works ...	10	10 %	10 %	...	21 — 22	21 — 22	21½	...
300,000*l*	Do. do. do. 4 % 1st Mort. Deb	100	...	...	...	101 —104	101 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	3½%	3⅜%	3¼%	8⅛— 8½	8⅛ — 8½	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5	...	13 — 13¼	13 — 13¼	...	...
	§Rosling, Appleby & Fynn 6 % Cum. Pref.	£1	...	...	6 %	... — ...	19/- to 20/-	...	...
37,350	Telegraph Construction and Maintenance	12	15 %	15 %	17½%	35 — 39	35 — 39	38½	37½
150,000*l*	Do. 4 % Deb. Bds. Nos. 1 to 1,500 Red. 1909 ...	100	...	...%	...	102 —105	102 —105	...	...
20,000	Telegraph Manufacturing, Ord. Nos. 1 to 20,000	5	8 %	12 %	12 %	10½— 11½	10½— 11½	10⅝	...
20,000	Do. do. 5 % Cm. Prf. Nos. 1 to 20,000 ...	5	...	...	...	5½— 6	5½— 6	...	...
540,000*l*	Waterloo and City Railway, Ord. Stock	100	3 %	3 %	3 %	94 — 97	93 — 96	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. § From Bradford Share List.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Consolidated Telephone Construction and Maintenance, ⅛—⅜
National Electric Free Wiring, 12/6 paid, ⅞—1⅛.

Oldham, Ashton, and Hyde Electric (£10 pd.), Ord., 15½—16½.
Do. do. Pref. (£10 pd.), 10—11.

*T. Parker, £10 (fully paid), 16½.

* From Birmingham Share List.

Bank rate of discount 3½ per cent. (June 6th, 1901).

MARKET QUOTATIONS, Wednesday, June 12th.

CHEMICALS, &c.	This week.	Last week.	Inc. or Dec.
a Acid, Hydrochloric .. .. per cwt.	5/-	5/-	..
a ,, Nitric .. .. .. per cwt.	22/-	22/-	..
a ,, Oxalic .. .. .. per cwt.	32/-	32/-	..
a ,, Sulphuric .. .. .. per cwt.	5/6	5/6	..
a Ammoniac, Sal .. .. .. per cwt.	39/-	39/-	..
a Ammonia, Muriate (crystal) .. per ton	£33 10	£33 10	..
a ,, ,, .. per ton	£30	£30	..
a Bleaching powder .. .. per ton	£7	£7	..
a Bisulphide of Carbon .. .. per ton	£15	£15	..
a Borax .. .. per ton	£17 10	£17 10	..
a Bensole (90 %) .. .. .. per gal.	7/-	7/-	..
a ,, (50/90%).. .. .. per gal.	5/6	5/6	..
a Copper Sulphate .. .. per ton	£23	£23	..
a Lead, Nitrate .. .. .. per ton	£24	£24	..
a ,, White Sugar .. .. per ton	£31	£31	..
a ,, Peroxide .. .. .. per ton	£27 10	£27 10	..
a Methylated Spirit .. .. per gal.	2/6	2/6	..
a Naphtha, Solvent (90% at 160° C). per gal.	5/6	5/6	..
a Potash, Bichromate, in casks.. per lb.	8¾d.	8¾d.	..
a ,, Caustic (75/80%) .. .. per ton	£24	£24	..
a ,, Bisulphate .. .. .. per ton	£35	£35	..
a Shellac .. .. per cwt.	61/-	61/-	..
a Sulphate of Magnesia .. .. per ton	£4 10	£4 10	..
a Sulphur, Sublimed Flowers .. per ton	£6	£6 5s.	..
a ,, Recovered .. .. per ton	£5 10	£5 10	..
a ,, Lump .. .. .. per ton	£5	£5	..
a Soda, Caustic (white 70 %) .. per ton	£10 15	£10 15	..
a ,, Crystals .. .. .. per ton	£8	£8	..
,, Bichromate, casks .. per lb.	2¾d.	2¾d.	..

METALS, &c.			
b Aluminium Wire, in ton lots.. per ton	£224	£224	..
b ,, Sheet, in ton lots per ton	£191	£191	..
p Babbitt's metal ingots.. .. per ton	£75 to £140	£75 to £140	..
c Brass (rolled metal 2" to 12") basis per lb.	7¼d.	7¼d.	..
c ,, Tube (brazed) .. .. per lb.	10d.	10d.	..
c ,, ,, (solid drawn) .. per lb.	8¼d.	8¼d.	..
c ,, Wire, basis .. .. per lb.	8d.	8d.	..
c Copper Tubes (brazed) .. per lb.	11d.	11d.	..
c ,, ,, (solid drawn) .. per lb.	10¾d.	10¾d.	..
g Copper Bars (best selected) .. per ton	£85	£85	..

METALS, &c. *(continued.)*	This week.	Last week.	Inc. or Dec.
g Copper Sheet .. .. .. per ton	£85	£85	..
g ,, Rod .. .. .. per ton	£85	£85	..
c ,, (Electrolytic) Bars .. per ton	£82	£82	..
c ,, ,, Sheets .. per ton	£90	£90	..
c ,, ,, Rod .. per ton	£84	£84	..
c ,, ,, H.C. Wire per lb.	9¾d.	9¾d.	..
f Ebonite Rod .. .. per lb.	8/-	8/-	..
f ,, Sheet .. .. .. per lb.	5/-	5/-	..
n German Silver Wire .. .. per lb.	1/5	1/5	..
h Gutta-percha fine .. .. .. per lb.	8/-	8/-	..
h India-rubber, Para fine .. .. per lb.	3/9 to 3/10	3/9 to 3/10	..
i Iron, Charcoal Sheets .. .. per ton	£18	£18	..
i ,, Pig (Cleveland warrants) .. per ton	45/2	45/6½	4½d. dec.
i ,, Forgings, according to size per ton	From £11	From £11	..
i ,, Scrap, heavy .. .. .. per ton	70/- to 72/6	70/- to 72/6	..
i ,, Wire, galvanised No. 8 .. per ton	£10 5	£10 5	..
g Lead, English Ingot .. .. per ton	£12 12 6 to £12 15 6	£12 10 to £12 12 6	inc.
g ,, ,, Sheet .. .. per ton	£13 10	£13 10	..
m Manganin Wire No. 28 .. .. per lb.	8/-	8/-	..
g Mercury .. .. per bot.	£9 2 6	£9 2 6	..
d Mica (in original cases), small .. per lb.	3d. to 9d.	3d. to 9d.	..
d ,, ,, ,, medium per lb.	1/9 to 2/9	1/9 to 2/9	..
d ,, ,, ,, large .. per lb.	3/3 to 7/3	3/3 to 7/3	..
p Phosphor Bronze, plain castings per lb.	1/0½ to 1/3	1/0½ to 1/3	..
p ,, rolled bars & rods per lb.	1/1 to 1/4	1/1 to 1/4	..
p ,, ,, strip & sheet per lb.	From 1/3	From 1/3	..
o Platinum .. .. per oz.	£4 1	£4 1	..
p Silicium Bronze Wire .. .. per lb.	10½d. to 1/0½	10½d. to 1/0½	..
i Steel, Magnet, acc'd'ng to desc'p'n per ton	from £15	to £40	..
i ,, ,, in bars	£58	£58	..
g Tin, block .. .. per ton	£133 10 to £134	£130 10 to £131 10	inc.
g ,, foil .. .. per lb.	1/6	1/6	..
n ,, wire, Nos. 1 to 16 .. .. per lb.	1/9	1/9	..
p White Anti-friction Metals —			
"White Ant" brand .. .. per ton	£35 to £65	£35 to £65	..
j Yarns, Cotton, Single 10 lb. b'ndl's per lb.	8½d.	8¾d.	..
j ,, Best Flax, 6 lea. .. .. per lb.	6d.	6d.	..
j ,, Hemp, 3 ply 10 lbs. .. .. per lb.	4¾d.	4¾d.	..
j ,, ,, Russian, 10 lbs. .. per lb.	5¾d.	5¾d.	..
j ,, Jute, 180 lbs. rove .. per ton	£14 5	£14 5	..
k Zinc, Sh's. (Vielle Montagne bnd.) per ton	£22 10	£22 10	..

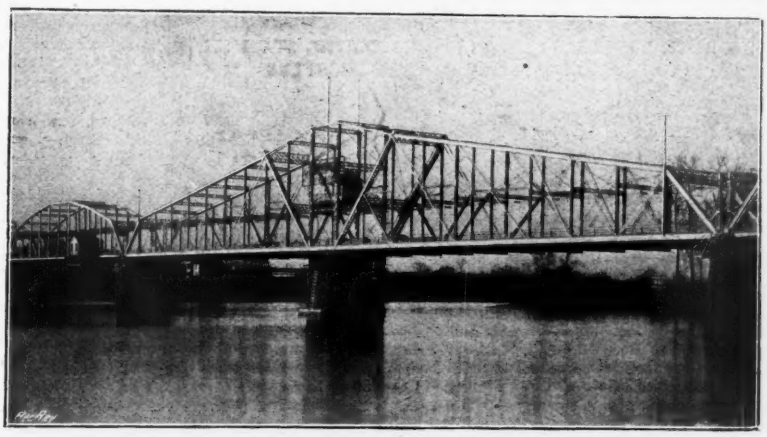
Quotations supplied by { *a* Messrs. G. Boor & Co. *b* The British Aluminium Co., Ltd. *c* Messrs. Thos. Bolton & Sons. *d* Messrs. F. Wiggins & Sons. *e* Messrs. Frederick Smith & Co.

Quotations supplied by { *f* India-Rubber, G.-P. and Teleg. Works *g* Messrs. James & Shakspeare. [Co., Ltd. *h* Messrs. Jackson & Till. *i* Messrs. Bolling & Lowe. *j* Messrs. Henry C. Yee & Co.

Quotations supplied by { *k* Messrs. Morris Ashby, Limited *m* Messrs. W. T. Glover & Co., Ltd. *n* Messrs. P. Ormiston & Sons. *o* Messrs. Johnson, Matthey & Co., Ltd. *p* The Phosphor Bronze Company, Ltd.

SWING BRIDGE AT MIDDLETOWN, CONNECTICUT.

THE new highway bridge across the Connecticut River at Middletown, Connecticut, designed by Mr. H. G. Tyrrell, Boston, is 1,300 ft. long, with a 26-ft. roadway, and provision for two 6-ft. sidewalks. It contains the longest highway swing span in the world. Besides the street traffic, it carries a line of electric railway, connecting Middletown with Portland. It consists of two fixed spans, 200 ft. centre to centre of piers; two fixed spans, 225 ft. centre to centre of piers; one draw span, 450 ft. centre to centre of piers. The turn-table is entirely rim bearing. Eight loading beams transfer the weight to 16 points on the drum, which is 4 ft. deep and 31 ft. diameter. This stands on 64 cast-steel wheels, 8 in. by 16 in., which run between cast-steel bevelled treads 2 in. thick at the centre. The lower tread rests on wrought-steel plates bolted to the masonry. This arrangement of turn-table makes a simple construction, and is believed to be as effective for a highway draw as some of the more elaborate combinations of rim and centre-bearing turn-tables, which depend on their adjustment for an even distribution of load. The drum and wheels are secured in place to a centre casting by means of the usual radial braces and spider frame. This centre casting is set down 6 in. into the stone pier, and secured to it by means of eight bolts 1¼ in. diameter and 6 ft. long, built solid into the pier; it has a hollow centre for the passage of wires up to the bridge. The swing is operated by three 25-H.P. electric motors of railroad type, one for turning, and the others for blocking up the ends. Besides these there is a fourth motor and a duplicate set of turning machinery all in place, which can be used in case of unbalanced wind pressure or a break in the other machinery. These two sets can be worked independently or together, at the will of the operator. Power is taken from the Middletown street wires; a cable is laid on the river bottom, and brought up on the centre pier. It passes in a groove under the wheel track, and up through the centre casting. The operating house stands on an overhead platform in the centre tower. It has large windows on four sides, and an overhanging sunshade eave. The walls and floor are double thick, and it is provided with electric heating for cold weather. The platform is reached by means of a ladder from the bridge floor. It was originally intended that the closing of the gates should be done by the operator in the tower, and, in fact, the engineer made a complete design for electrically-worked steel safety gates. While these would cost $950 for the two gates, they would do away with the services of two gate operators, but on account of an accident to the substructure, involving extra expense, the steel gates and some other machinery were omitted. This last was an arrangement for closing the space between the ends of rail, where the draw and fixed span join. In cold weather this opening is liable to be 2 in. or more. As this would cause a serious jar to cars, and possibly a derailment, the engineer has designed machinery to close this space while the toggles were tightening. There is also a lifting steel apron plate to cover the curved openings in the floor at the end of the draw, to lift up before the bridge is opened. Instead of the moving rail, an ordinary split rail is used that can be adjusted occasionally with the changing seasons, and instead of the safety gates, a pair of temporary wood ones are now in use. As already stated, the blocking up of the ends is done by two separate motors at the ends of draw placed beneath the floor. It is not infrequent to bring power from the centre by means of a shaft; but the writer's experience shows that for long draw spans this method is not satisfactory, as too much power is lost by friction in the boxes. The calculated deflection of the ends was 3⅜ in., and after the bridge was completed and levels taken, the actual deflection was found to be 3⅞ in. Blocking up the ends is done by means of a pair of toggles at each corner. These are drawn together by two bronze nuts working on a right and left-hand screw, that is turned by bevel gears from the motor. To prevent these nuts from jamming, there are electric signals that tell the operator when to shut off his power. As a general rule, it is intended to simply block the ends up tight. This requires but very little power. But as there is always the liability of the blocks becoming tight from change of temperature or other causes, the end machinery was proportioned to lift 50 tons at each corner, 1½ in. in 10 seconds. This required 10 H.P., but it was thought best to use the same kind of motor used at the turn-table, giving interchangeable parts. To provide for expansion the end toggles rest on cast-steel rockers of 17½ in. radius, which in turn bear on cast-iron pier plates, blocked up to the right elevation. The floors of fixed span and draw were made to level up, but notching the joint. The latch is an extra heavy swinging gravity latch, to which is attached a line of No. 10 wire passing over pulleys to the centre, and connected by means of bell cranks with the operator's house. To open by electric power takes 30 seconds, and the power required to overcome an unbalanced wind pressure of 5 lbs. per foot on one-half of bridge is 30 H.P. Ordinarily, however, in calm weather 5 H.P. is sufficient to turn. It was necessary to use about four times the amount of resistance ordinarily used on street-car work with the same motors. The reason for this is evident when the relative weights of bridge and car are considered. Both the centre and end sets of machinery are provided with clutches, which can be thrown out of gear, and the operation performed by hand power. Working on 10 ft. levers, the bridge is turned by four men in 8 minutes. There is a friction brake applied to a drum on the highest speed turning shaft. This, and the other turning machinery, including the motor, are placed on the outside of drum beneath the floor, in a machinery frame that can be sheathed in and protected from snow and ice. The whole bridge is well lighted with incandescent lamps, and has also the usual signal lights required by the Government.



ELECTRICALLY-OPERATED SWING BRIDGE.

CHANCES FOR YOUNG ENGINEERS IN MEXICO.*

BY J. M. ALARCO, Manager La Luz Electrica De Aguascalientes.

THE subject is not new but deserves attention, especially of young engineers just out of school looking for work and for a field of action. From my personal experience and constant intercourse with engineers in this country, my opinion is that the chances here are good, but although it may seem presumptuous, let me name some of the requisites to success.

In the first place, that which is necessary for success in all countries, and under all circumstances: Don't be afraid of work. Not only that, but show your employer you are willing and eager to do work. Next learn to speak and understand the Spanish language, which is worth 100 per cent. of your salary at the start, and 1,000 per cent. later on. It has been my experience, I am sorry to say, that about one in every fifty of the Americans in this country know Spanish only well enough to make themselves understood. Few take the trouble to learn Spanish thoroughly, consequently they fill only the lower position in an office; and those that know it well, although probably not as efficient in their work, step above them and advance rapidly. Choose your employer if possible, above all select a gentleman and one who is willing to teach you. Another mistake of the Americans is that as soon as they are one month in Mexico, alcohol and other things not to be mentioned get the best of them. They burn the candle at both ends and do not last long.

But outside of this general advice, it is best when coming here to be in the employ of a foreign firm, or come to fill a position secured before hand—unless you have some capital to start for yourself. Mexicans as a general rule are not enterprising, and those that are and have money will award the contract for any enterprise they may undertake to a foreign firm and will employ foreign skill.

Opportunities there are galore. Every town of importance has an electric light system or is thinking of putting one in. All of them need a sewer system and public water supply. The matter is just waiting for some enterprising American firm to hustle it through. Although as a general rule the treasury of most cities is empty, they have the advantage of not being bonded, leaving therefore an untouched source of revenue and a way of raising money for future enterprises.

As for mining, there is a constant demand for a man willing to begin at the bottom, with the probabilities of taking a claim for one's self. The mining laws of Mexico are excellent, and claim jumpers do not exist. They died long ago of an indigestion of lead.

Mexican peones have to be treated in a special way. They are like children, need to be praised and patted on the back every now and then, and must have a regular day off on their feast days. They need to be "called down," but without any cursing, for although they

* The *Technograph*.

do not understand English, they know you are swearing at them and will tell you: "I do not have to work. There are tunas in the mountains." Tunas are fruits that grow on the wild cactus and which furnish the peones with all the nourishment they need, during the three months that the tunas last; consequently when the peones do not want to work, they will camp out and live on tunas as long as they last.

If the engineer, after graduating, stays in the States a couple of years, and gains the practical knowledge necessary to supplement the theory he has learned in college, then he can command a situation here in any branch of the profession. But do not let him come with the idea that he will find an up-to-date machine shop in the whole country, or that any of the standard size materials can be bought in the open markets as in the States. When erecting a plant of any kind he must learn to use the material at hand, and operations that are done in the States with lathe or shaper must frequently be done here with hammer, chisel, hack-saw, and file. If the specifications call for brick and cement, he must most of the time content himself with adobes, mud, and lime.

Economy in the use of fuel is of the utmost importance here, for coal costs from $8 to $10 gold per ton; and fuel saving devices such as condensers, heaters, and economisers, if not already attached to the engine, must be bought or contrived by the engineer or manager.

Any good engineer will get from $90 to $150 gold per month. As his living expenses are more than 50 per cent. lower than in the States, it follows that more money can be saved. The field is not crowded by any means, and all it needs is to get down here and hustle, and success will follow.

Last but not least, be polite to the Mexicans. Do not look upon them as "greasers" and an inferior race; a smile, the lifting of your hat, or an inquiry about their health, will do more to help you in some cases than any amount of hard work.

INSTITUTION OF ELECTRICAL ENGINEERS.

STORAGE BATTERIES IN ELECTRIC POWER STATIONS, CONTROLLED BY REVERSIBLE BOOSTERS.

By J. S. HIGHFIELD, Member.

(*Paper read May 9th*, 1901.)

THE use of storage batteries in direct current central stations has now become general, but there seems to be a great divergence of practice among station engineers in the matter of the proportion that the battery bears to the steam plant. A table in the appendix gives the proportion of the battery capacity to the steam plant capacity in many direct current stations, the figures having been obtained through the courtesy of the engineers of the various towns in supplying the figures. There seems to be no good reason for this great diversity of practice, and this paper is written with the object of putting before engineers what seem to be the chief points in considering the designing of batteries for the work they are called on to do in central stations, and to describe subsidiary apparatus which may be found of use and convenience in operating batteries. It is convenient to divide stations into three varieties, namely, (1) lighting and general supply stations, (2) traction stations, and (3) combined stations for supplying to the general town network and to a tramway system.

In laying down a station for a general town supply, where the load factor may not be more than 12 per cent., and where the difference of the magnitude of the load in winter and summer is great, it has been customary to instal a battery having a capacity, reckoned at a three-hour rate of discharge, of but a small proportion of the whole station plant. This battery is usually very useful in the first years of the supply, but as the load increases from year to year, the battery is worked altogether beyond its capacity, and so falls into a bad state of repair, and into disuse; and additions to plant do not very often include corresponding additions to the battery. This ill-treatment of the battery is very frequent in stations where the battery works the night shift, as there is a great temptation to delay increasing the capacity of the battery or the hours of working the plant till the last possible moment, and the battery under these circumstances is frequently run down; needless to say, it is very soon irreparably damaged. It seems hardly necessary at this date to insist on the absolute necessity of using storage batteries with the greatest care, of giving them at least as much skilled attention as the rest of the station plant. If an armature becomes grounded, or a commutator damaged, the repairs are not a very serious matter, but neglect of a battery, too heavy charging or discharging, insufficient charging, and over-discharging, damage to some extent every plate in the battery, and consistent treatment of this sort will rapidly reduce the storage capacity and the efficiency of working at the same time.

In an ordinary lighting and general supply station the battery is nearly always divided into two parts—one, the main battery, consisting of a number of cells arrived at by dividing the pressure in volts maintained at the bus bars by 2·5, the usual voltage at which charge is assumed to be complete; the remaining part of the battery consists of such a number of cells as to make the whole number in the battery equal to the figure obtained by dividing the bus bar volts by 1·85, the lowest pressure to which it is usual to allow each cell to fall on discharge. This second, or regulating section of the battery, is connected to switches which enable more or less of the regulating cells to be connected to the bus bars. The arrangements differ somewhat in different stations, but substantially this is universal practice. For charging, a special dynamo is run at the necessary pressure, or boosters are used to raise the bus bar pressure to that desired.

These devices of heavy regulating switches, boosters, and their connections, are exceedingly costly, and very difficult to operate in practice; moreover, the risk of short circuits between the bars connecting to the regulating switches is somewhat great, and in most stations the battery switch gear is more complicated and more costly than any other part of the switching equipment. The arrangements for charging the battery are two: one is to disconnect the battery entirely from the working bus bars, and to connect it to bars at a higher pressure, cutting out the regulating cells as they become charged; the other is to connect the cells to the charging bars, and to connect a less number of cells to the supply bars. In this case the charging current is greater in the end cells than in the remainder of the battery; in either case it is quite impossible to properly charge the regulating cells, and it is nearly always found that these, excepting possibly the last two or three, which are rarely used, depreciate at a far greater rate than the other cells in the battery.

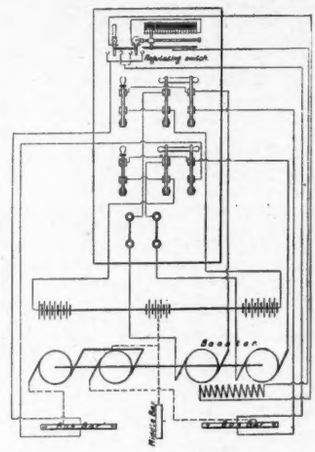


FIG. 1.—ARRANGEMENT OF VARIABLE PRESSURE LIGHTING BOOSTER.

After trying the regulating cell system, I decided to eliminate entirely this source of trouble and expense, and the arrangement I have used for the past two years is to regulate entirely by means of a variable-pressure booster, so designed that by varying the field strength the pressure can be varied from zero to a maximum in either direction. The booster has a double-wound armature working in one field, each half of the battery is connected in series with one of the armature windings, and the field is varied by a 30-point rheostat and a reversing switch interlocked therewith in such a way as to vary the volts given by each armature from zero to 50, each step of the resistance serving to effect a variation of rather less than 2 volts. The booster is fitted with carbon brushes worked at very low current density, and no trouble is experienced when the current is large and the field strength small. The battery supplies a three-wire system, the middle point of the battery being connected to the neutral bus bar; a very good type of balancer is also used, so that the out-of-balance current dealt with by the battery is small. One half of the battery may be charged by disconnecting the other half entirely from the bus bars, and charging through the balancer.

The arrangement of electrical connections is shown diagrammatically in fig. 1. The switch gear required to connect or disconnect the booster and the battery is exceedingly simple, and of course the whole of the necessary regulating is done by varying the amount and direction of the booster as desired.

The battery is always connected to the bus bars, and one of the most convenient purposes it serves is to act by means of the booster as the controller of the station pressure, which is regulated solely by the switch handle, which regulates the strength of the booster field, and hence varies the amount of boost.

The arrangement here described was the first one I designed. It has proved an immense improvement on the regulating cell system, but has the objection that a sudden variation in the load causes a variation in the pressure. It is very desirable to make the regulation of the station as automatic as possible, provided that no very delicate gear is used, and the automatic booster to be shortly described, would certainly be an improvement on the one above mentioned. I am at present arranging to use an automatic booster in connection with a three-wire lighting battery. The arrangement of the switch gear shown on fig. 1 is not the best. I am now arranging to use an interlocked gear designed to prevent all possibility of accident by a careless operator.

The method of operation is as follows:—

Should the pressure rise by reason of a diminishing load, the boost is varied so as to cause the battery to discharge less, or to charge more. Should the pressure fall, the booster is regulated so as to work in the opposite sense. If the speed of the generators is arranged for full load at the correct pressure, by regulating the

station pressure by the booster and battery, the generators will always, in almost automatic way, be kept at full load, provided always that the battery is of proper capacity.

The battery, of course, also serves as a store of energy, which is used to drive the entire load when it is so small as not to be sufficient for a single generator. There are, therefore, three purposes which the battery serves to fill.

1. It serves, with suitable means of regulation, as a controller of the station pressure.

2. It serves as a store, so that the running generators may be always fully loaded, and also it may carry the peak of the load, and so serve to improve the load on the steam-raising plant.

3. It serves as a store of energy which may be drawn on at times when the load is within its capacity.

In stations of small size up to, say, 1,000 KW., the battery is of immense use in steadying the pressure, especially when a few rather large motors are connected to the mains; in large stations where units of large size are used, this is not a matter of so much importance.

The battery is also a great source of security in the case of partial short circuits on the mains; it will easily burn a fault, which might damage the generators, and with very little fall in the pressure. I have had experience of several cases where the battery has burnt a bad main's fault clear, the first news of such an accident coming from the outside gang.

To fully fulfil the above purposes, it is necessary to properly proportion the battery to the work which it has to do in relation to the work done directly by the running plant, and it is necessary to take into account the capital cost of batteries in order to decide to what extent it is advisable for financial reasons to instal them in a central station. It is convenient to work out the cost of the battery per kilowatt of discharge at various rates. Fig. 2 gives the cost per kilowatt of storage batteries, including the booster and switch gear complete and ready for work, but excluding the cost of the battery house. The table applies to batteries for 480 to 500-volt circuits, consisting of 240 cells, which is the best number to use for 460 to 480-volt lighting circuits when the booster method of control is adopted. The gear is all designed to work at the one-hour rate—if designed for the three-hour rate a reduction of about 10 per cent. would be made. The cost of steam and electrical plant—excluding buildings—may vary from £25 to £50 per kilowatt capacity. Taking £35 as the usual figure for small stations, it will be seen from the curves (fig. 2) that at about a three-hour rate of discharge the battery costs per kilowatt of possible output the same amount as the running plant, and as the size of the battery increases the cost per kilowatt somewhat decreases. At a one-hour rate of discharge the cost of the battery is less than the cost of plant of a similar output. The "peak" of a lighting station does not usually last for more than two or three hours in a town where late-closing shops make up a large proportion of the load. The proportion of the maximum load constituting the peak varies from one-quarter to one-sixth—that is to say, if the peak is defined as an amount of load constituting one-fourth to one-sixth of the maximum load, this peak does not remain on for more than three hours, it is usually less. If the battery is to take the whole of the peak, it must therefore be designed to have a capacity, reckoned at the rate of discharge which will run it down in three hours, of at least one-fourth to one-sixth of the maximum load on the station. In a new station of moderate size the battery might be made to bear a larger proportion to the plant installed than this, as large batteries and their controlling gear are somewhat less costly than small ones, and are also less trouble, owing to the fact that they are usually more solidly constructed.

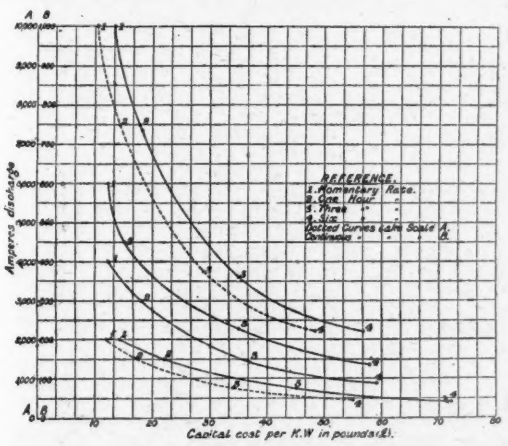


Fig. 2.—Cost of Batteries with Reversible Booster and Switch Gear Erected Complete.

The batteries consist of 240 to 250 cells, and the capacity is taken as 80 per cent. less than the full rated capacity when the battery is new, so that at the end of a period, depending on the work and treatment of the battery, the actual capacity will be up to its rated value.

A battery of sufficient size to carry the peak for three hours will be able to serve the three purposes set forth above in a very complete way, and the loss of energy in the battery will generally be amply compensated for by the increased economy due to working the engines at full load, and to the improvement of the steam-raising plant load factor. The load factor of the steam-raising plant is usually very poor, the fuel wasted in raising steam and keeping hot long ranges of pipes constitutes a considerable portion of the fuel usefully consumed. It seems impossible to lay down general rules as to the working of boilers in electric works; the only thing to be said, a fact readily conceded, is that the greater the regularity of working of the steam-raising and distributing plant the greater will be the economy. In works of 1,000-KW. capacity or less it will be generally most economical to drive the load from midnight to 6 a.m. from the battery—in summer time the load may be often carried in this way for a longer period—and a battery designed to carry the peak for three hours will generally be sufficient to do this. The boiler fires would be banked during these hours, and one shift of men saved.

In larger stations, however, the coal thus used would be nearly as much as if an engine were running all night, and probably in stations above 1,000 KW., and certainly in stations above 2,000 KW., it would be more economical to drive the load from the running plant, charging the battery to keep the engine at full load. Then on the load rising in the morning the battery would be discharged until the demand increased sufficiently to load up a second engine, again charging the battery.

Small stations supplying residential towns must be considered on a somewhat different basis from large stations supplying manufacturing towns in respect of the use of batteries as of other matters. In a small station the battery can supply economically a far greater proportion of the yearly output than in a large station.

In stations of less capacity than 500 KW. the usual practice has been to put down at least two sizes of engines; it might be better practice to put down two or three engines of equal size and a battery of sufficient capacity to give the output of one engine for three hours. It is not difficult to predict the extent of the load in residential towns of small size, and if it be assumed that in, say, five years' time, 800 KW. will be required, a station laid down with two 100-KW. generators, and a battery capable of giving about 100 KW. for three hours, will make a far more economical station than one in which one or two smaller units are put down to start with. As the load on such a station increased, engines of similar size to those first installed should be put down, the plant being thus maintained of uniform pattern.

In stations of larger size a greater number of units would be installed, and in order to load up the running engines to their full capacity it would usually be necessary to instal a battery equal in capacity to the output of one engine for three hours, so that in general the ratio of the battery capacity to the total capacity of the plant will be less in large stations than small ones in inverse proportion to the number of units.

In determining the best size of battery for an existing station, the engineer might consider into what number of units he would divide the plant if he could design and erect an entirely new station. Most engineers in such a case would probably decide to make all the units of similar capacity; the battery should then be of such size as to take the whole output of one unit for a period of three hours, or alternatively two units, of, say, one-half of the capacity of the standard unit, might be installed, and a battery equal in capacity to one of these units. The nature of the all-night load must be considered in this connection, however, and the size of the smallest unit and of the battery should largely be determined by the amount of the load from midnight to 6 a.m.

In the case of a station with a large street-lighting load it is not difficult to ensure that the engines are always nearly fully loaded, but even in such a case a large battery will also enable the steam-raising plant to be worked in a more uniform way, a matter as important for economy as the uniform working of the engines.

To consider a special case, a plant of 1,000 KW. will, with a load having a factor of 10 per cent. turn out per annum 870,000 units. If by the use of a battery giving 250 KW. for three hours, which, as before explained, is in most cases capable of dealing with the peak, running plant of 750 KW. capacity could do the work, and turn out the same number of units, the plant load factor would be raised from 10 per cent. to 13·4 per cent., an increase which would certainly result in greater economy in working; but such a battery would be in nearly every case capable of carrying the whole of the load from midnight to 6 a.m. The plant could then be shut down during these hours and one shift of men saved, the running hours being lessened to this extent, the plant load factor would be raised from 10 per cent., where no battery was used, to 17·8 per cent. In most towns also this battery would, in summer time, serve to carry the load during a part of the day, and the plant load factor would be thereby still further increased. The above factor applies to the whole plant over the whole year, but since the plant would be divided into, say, four units of 250 KW. each (one unit being spare) the plant actually working could be kept always fully loaded if the battery were charged and discharged in a proper manner to attain that end.

The question of the relation between cost of working and load factor will be further considered in referring to combined stations, but reference may here be made to the fact that a lighting station deals with a load which varies through a wide range during every day, but it varies in an easily predetermined manner. With properly-proportioned sub-divided plant it is easy to ensure that the running engines always work at or near their full load; the average load on the plant considered as a whole, however, simply depends on the outside load, as will, to a great extent, the load on the boilers. In a lighting station, therefore, the battery should be designed to equalise as much as possible the boiler working. A battery sufficiently large to obviate raising steam, even in a single boiler which might not be required for more than an hour, will enable a considerable saving to be made in fuel.

The efficiency of battery working is a most important factor, since every unit supplied from the battery costs more than

the units supplied direct by an amount depending on the efficiency. I have results obtained from a battery of 240 cells capable of giving 100 KW. for three hours. The units were metered through a watt-hour meter, which recorded

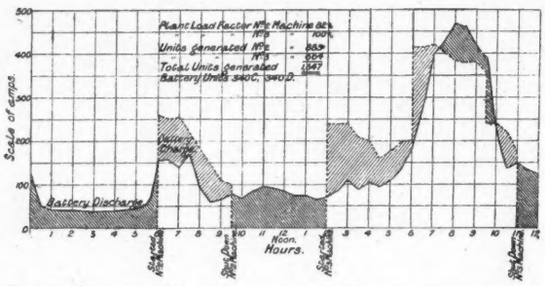


FIG. 3.—LIGHTING LOAD DIAGRAM. GENERATOR AND BATTERY.

charge and discharge separately, and which was checked by the switchboard ammeters and voltmeters from time to time, and was found to be sensibly correct. The units of charge from July 1st to December 31st were 62,560, and of discharge 46,390 for the same period, corresponding to an energy efficiency of 74 per cent. The battery is charged at varying rates to suit the load on the engines. The charging current starts at 170 to 200 amperes, and varies from time to time as the outside load varies, but it never exceeds 70 amperes when the cells are full. The maximum charging pressure per cell is 2·41 volts, the minimum discharging pressure 1·9 volts; the average charge per 24 hours is 341 units, the average discharge 253 units: the maximum discharging current is 200 amperes. Additional figures are given in the Appendix. The battery has cost for repairs a small amount, consisting of labour in filling up the cells with water, and in cleaning. Two faulty positive sections were replaced by the makers, otherwise no work has been done in keeping the battery in order.

The usual directions of the makers are impossible to carry out in practice, and I find the most convenient method of keeping note of the condition of the cells is to make a weekly test all round of the specific gravity of the electrolyte, being careful to take the readings only when the cells are fully charged by the switchboard volt-

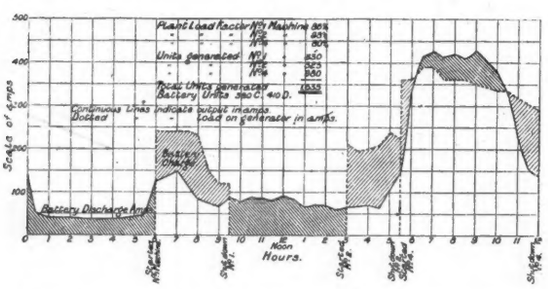


FIG. 4.—LIGHTING LOAD DIAGRAM. GENERATOR AND BATTERY.

meter. By comparing the results with those last taken, it is easy to see if the proper amount of charge has been given during the week; if the specific gravity has fallen, rather more charge is given to bring it right up again. From the results obtained of battery working at various times, I am of opinion that charging with a constant current at the battery maker's usual figure is not so conducive to efficient working and to the long life of the cells, as finishing up the charge at quite a small current. On the other hand, the charging current at the commencement, when the cells are empty, may safely be much greater than the maker's figure. It would be most interesting to have accurate figures over a great number of charges and discharges, giving the efficiencies of various methods of working and at various rates of charge and discharge. The curves in figs. 3 and 4 show the ordinary work done by the battery on the lighting load in the station of which I have charge.

There is one point to which I have not alluded, and that is, the immense convenience that a battery is when repairs have to be done to steam pipes or valves. The advantage of being able to shut down entirely and still keep the mains alive is so great that for this reason alone a battery in a central station is almost a necessity, at any rate, where a motor load exists. In such a case a shut down even for a few hours on Sunday is almost impossible, and on a week-day cannot be tolerated.

Apart from this use of batteries in the power station, there may arise occasions when the battery may be used in a sub-station at one or more important feeding points. About 15 per cent. of the copper put down in feeders is only required for a few hours each day for perhaps one month in the year, from the middle of December to the middle of January. This copper can be saved by using a battery in a sub-station, provided of course that a site can be found at not too great a cost. In addition to the saving in feeders, the economical area of distribution can be extended, and the pressure can be maintained more nearly constant. It is not possible to lay down general rules for the use of batteries in this way, but I now have a case where it is necessary to give supply at a point about three miles from the station. The extent of the supply will be about 100 KW. There is an excellent site for a sub-station about two and half miles from the station, and a battery at this point works out at a less first cost than a boosted direct feeder, or a high-tension transmission scheme.

(To be continued.)

AN INSTRUMENT FOR MEASURING THE PERMEABILITY OF IRON AND STEEL.

By C. G. LAMB, M.A., B.Sc., Associate-Member; and MILES WALKER, B.A., Associate.

(Paper read May 2nd, 1901.)

THE instrument described in this paper has been designed to meet the demand for a simple, cheap, and reliable piece of apparatus for measuring the permeability of iron and steel. The authors have tried to construct an instrument which would be extremely simple to use, and whose calibration should be dependent on such principles as should render it incapable of alteration with time and with somewhat careless usage.

The principle adopted is that of balancing the reluctance of an air-gap against that of the specimen under test by means of altering the length of the air-gap. Since the reluctance of such an air-gap of given dimensions is invariable, the accuracy of an instrument based on this principle depends only on the accuracy with which the dimensions of the air-gap can be measured, and the delicacy with which the point of balance can be ascertained.

In order to fulfil both these conditions, the instrument, as first used, is made as shown in fig. 1. The specimen to be tested consists

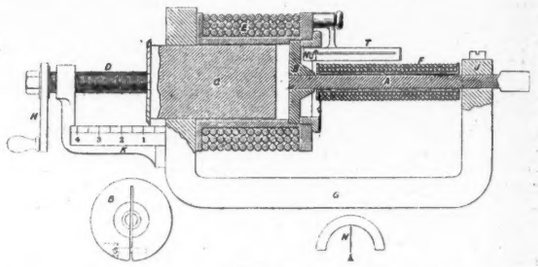


FIG. 1.

of a bar, turned up to a definite diameter (which we have taken as $\frac{8}{8}$ in.), and about 7 in. long. One end of this fits into an iron head B, provided with a hole of the right size to receive the specimen. Any slight looseness in the fit is taken up by the screw *s*, which draws together the two halves of the head, this being almost severed by a saw cut. Surrounding the specimen is a magnetising coil F, and the head B fits into a recess turned in another magnetising coil E, which is wound on the adjustable air-gap. The other end of the specimen is fixed to the yoke-piece G by the block J and two set screws. Opposite the end of the head B is the flat face of an iron cylinder C, which is 2 in. in diameter and $3\frac{1}{2}$ in. long. This slides freely, but with a good fit, through a hole in the yoke G, and can be moved parallel to its own axis by a screw D fixed rigidly to it, and working in a boss on the bracket K (fixed to the yoke G) by means of the handle H. This enables the operator very gradually to alter the length of the air-gap between B and the cylinder C. The number of turns, and fractions of a turn, made by the screw are read on the scale and graduated head shown in the figure.

In the instrument described, the coils E and F are wound with the same number of turns and are placed in series in such a manner that the magneto-motive forces on air-gap and specimen (which are in this case equal) act in the *same* direction—that is, they assist in creating the magnetic flux, the path of which lies through the specimen A, across the air-gap, along the cylinder C, and back by the yoke G to A. If the air-gap be so adjusted in length that its reluctance is equal to that of the specimen, then since the magneto-motive forces are the same for both, the flux of magnetism through each must be the same—that is to say, the whole of the lines of force coming from the specimen A must cross the air-gap, and none will escape from the back face of B. If, however, the reluctance of A be greater or less than that of the air-gap, the whole of the head B will be magnetised positively or negatively as the case may be. Its state may be indicated by means of a suspended magnetic needle placed in proximity to it. The needle used as an index is shown at N. It consists of a small curved steel bar pivoted on a jewel and needle point, and carrying an aluminium pointer. The latter is protected from air currents by means of a brass tube T, provided with two windows to observe the position of the index. These windows are covered with a slip of mica pushed into the tube. The whole arrangement can be detached at will by a thumb-screw.

Although the instrument described above has an equal number of turns on both specimen and air-gap, this is not essential, and we can easily show that any ratio can be used. Consider a circuit made up of an air-gap with T_1 turns of wire on it, and a specimen with T_2 turns of wire, and let it be a perfect circuit—that is, let no flux issue

from it into the surrounding air. Let ρ_1 and ρ_2 be the respective reluctances. When a current of A amperes is passing round the coil, and the same flux F is passing round the whole circuit (neglecting for the time any reluctance in the rest of the circuit) we must have

$$\rho_1 F = \frac{4\pi}{10} A T_1 \text{ and } \rho_2 F = \frac{4\pi}{10} A T_2, \text{ or } \frac{\rho_1}{\rho_2} = \frac{T_1}{T_2}.$$

Hence by merely altering the ratio of the turns on the air-gap and specimen we can balance the reluctance of the specimens with different lengths of air-gap. This may be of advantage when we wish to measure the reluctance of specimens in the neighbourhood of their maximum permeability, or at very high inductions.

The operation of testing a specimen after it is turned to the right diameter is as follows:—It is placed inside the coil F, and one end is inserted into the head B, which is then placed in the recess provided in the coil E, and fixed there by a thumb-screw as shown in the figure. The block H is then fixed in position, and the coils E and F being properly connected, are put in series with a reversing key, an adjustable resistance, an ammeter, and a few accumulator cells. For the purpose of more finely adjusting the current we often prefer to connect the apparatus up, as shown in fig. 2. The battery is placed in series with two resistances, conveniently about 10 ohms and 1 ohm, and the contact arms of these resistances are used to carry the current to the rest of the circuit; in fact, the current is supplied by a potential slide. This disposition, of course, entails some waste of current, but the advantage of being able very gradually to alter the current by small steps from zero to a maximum more than compensates for this disadvantage. This method will be found most convenient for all magnetic testing work. The amperemeter used is a Weston instrument reading to 1·5 amperes, but we have marked a second scale on it whose readings give directly the magnetising force, H, applied to the specimen, allowance having been made, in a manner afterwards briefly to be described, for the loss of magnetomotive force in the joints and yoke of the instrument. It is advisable before beginning a test to wipe out any magnetism that may be left in the instrument from a previous test by applying a fairly large magnetising force (say, H = 50), and reducing this through a series of reversals to zero. The alternative method of connection enables this to be done with great convenience and accuracy. The current is then adjusted until the amperemeter reads a definite value, say H = 5. The index needle will now be found hard over to one side, and if the current be reversed it will go hard over to the other side. The handle is then turned to lengthen or shorten the

Testing apparatus.

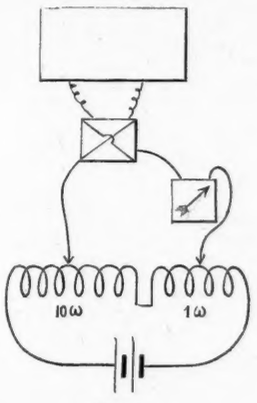


FIG. 2.

air-gap until the needle points to a central position. It is well to reverse the current once or twice before taking the final position of the handle so as to establish well the cycle for that particular magnetising force. The reading of the scale is then taken, and the calibration curves supplied with the instrument give the permeability or its reciprocal without any calculation. It is found that the movement of the needle enables the adjustment of the right length of gap to be made with the greatest precision. An alteration of about $\frac{1}{10000}$th of an inch is sufficient to disturb the balance. The degree of sensitiveness has been attained by having a strongly magnetised needle placed close to the head B, and controlled by a magnet so as to be just in stable equilibrium. A magnetised needle suspended parallel and near to a vertical iron plate is unstable, in the absence of outside controlling force, and the function of the magnet is to make the position just stable. It is adjusted in position to put the needle in its central position when the process of demagnetisation has been gone through, and before the test is actually commenced. In order that the readings of the instrument should be the same on reversal of the current, it is, of course, necessary that this process of demagnetisation should have been so carried out as to leave the circuit *completely* devoid of magnetism. This is not, in general, possible, and in practice great accuracy in the demagnetisation is not required. All that is necessary is to take readings for both directions of the current, and the mean of these is the true reading. This also greatly diminishes any effect of hysteresis in the yoke. It will be seen from Tables I. and II., which give the readings in a few tests made on Lowmoor iron and mild steel, that at fairly high inductions the two readings differ but little; at low readings the demagnetisation adjustment is more important. In obtaining the readings given in Table I. some care was taken in this respect, and in adjusting the needle exactly central by the control magnet; in the case of Table II. no special care was taken, and yet the readings were found to be quite reliable.

The scale-readings are found to be perfectly consistent for one specimen, and the important question arises whether the calibration curve is the same for specimens differing widely in permeability. The answer to that question is thoroughly satisfactory. Throughout the most important part of the magnetic curve, namely, the part dealing with the permeability at fairly high inductions, the readings of the instrument can be taken to measure the permeability within a fraction of 1 per cent. This was tested by obtaining the B-H curves of different specimens of material (viz., Lowmoor iron, mild steel, and hard steel) by Prof. J. A. Ewing's double-yoke method,* and calibrating the instrument in the

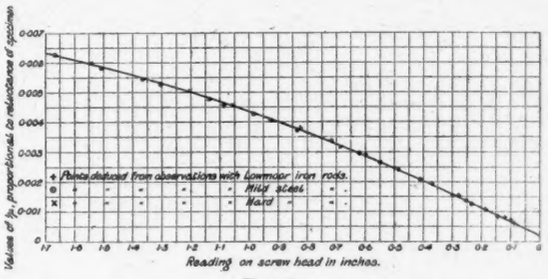


FIG. 3.

method described below. Since the dimensions of the specimen and gap are determinate and fixed, it would evidently be possible to engrave the cylinder so as to give the permeability (or its inverse) directly, but we found it convenient, in the first place, to read from an arbitrary scale of inches and one-thousandths, and connect with these quantities by calibration curves shown in figs. 3 and 4. Tested by means of these specimens, no distinction could be made between the values obtained with the different specimens within the limits of error of other measurements made in the observation. With regard to tests at low stages of the curve, it is doubtful if the use of small specimens is of much value for commercial purposes, since the behaviour of the iron under these low forces is so dependent on small accidents in its history that we can never be sure that the specimen represents the bulk; should the permeability under these conditions be required, the best method would be to build up an instrument from the material under test, and measure its permeability directly by a ballistic method. It is hence not a matter of great importance that at low inductions the end joints introduce an error varying with the material under test. The nature of this error may be considered as follows: the joints and yoke introduce a certain reluctance, and to drive the flux through this requires a magnetomotive force which is approximately proportional to the flux. It was found, for instance, that for an induction per square centimetre of 15,000 in a specimen of Lowmoor iron about 9 ampere-turns were required to overcome the joint and yoke resistance; the total ampere turns on the specimen was 298, so that 3 per cent. of the magnetomotive force was required for the joints and yoke. In a specimen of mild steel at the same flux-density the total ampere-turns required was 350, so that the percentage expended on the yoke and

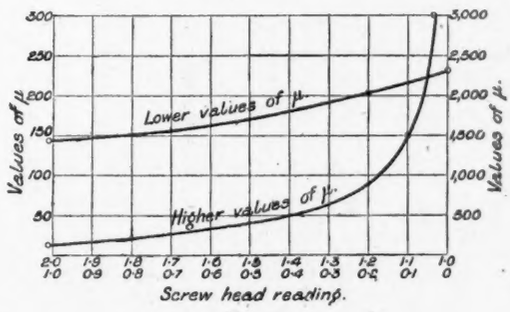


FIG. 4.

joints was 2·7. In the graduation of the amperemeter we made an allowance of 2·85 per cent. at this part of the scale for the loss of ampere-turns in the joint and yoke, so that the error at this point in reading H for either soft iron or mild steel was only of the order 0·15 per cent. At lower densities the effect of the joints is somewhat more important.

Details of the Calibration of the Instrument.—The calibration of the instrument was carried out in the following manner. Three pieces of Lowmoor iron were sawn off from the same bar and turned to gauge. They were not annealed, since in some previously used

* Ewing on "Magnetic Testing of Iron and Steel."—*Proc. Inst C.E.*, Vol. CXXI., Part 4.

specimens that had been carefully annealed, a question had arisen as to a change with time of the condition of the specimens. These were then tested in pairs by Ewing's double-yoke method. Two of the specimens were found in this way to agree very nearly indeed throughout the whole curve of magnetisation, while the third differed slightly in the early stages. One of the former pair was taken as standard, and was tested very carefully by the double-yoke method with the other as its return path. The ballistic

Table I.—Lowmoor Iron.

Current in coil in amperes.	H	B	$\frac{1}{\mu} \times 10^{-3}$	Length of air-gap in inches.		
				Readings with current in each direction.		Mean reading.
0·03	1·42	1,180	1·20	0·204	0·205	0·205
0·04	1·88	2,100	0·89	0·129	0·139	0·135
0·05	2·32	3,400	0·68	0·097	0·103	0·100
0·06	2·78	4,500	0·62	0·089	0·091	0·090
0·08	3·68	6,450	0·57	0·079	0·083	0·081
0·10	4·58	7,950	0·58	0·080	0·082	0·081
0·15	6·95	10,550	0·66	0·098	0·101	0·100
0·20	9·35	12,000	0·78	0·123	0·123	0·123
0·30	14·30	13,750	1·04	0·183	0·185	0·184
0·40	19·20	14,620	1·31	0·230	0·235	0·233
0·50	24·20	15,210	1·60	0·300	0·300	0·300
0·60	29·50	15,600	1·90	0·363	0·363	0·363
0·80	39·20	16,050	2·45	0·500	0·500	0·500
1·00	49·20	16,350	3·03	0·643	0·643	0·643
1·10	55·00	16,600	3·33	0·710	0·720	0·715
1·15	56·50	16,660	3·38	0·750	0·750	0·750
1·20	59·20	16,700	3·55	0·780	0·790	0·785
1·30	64·20	16,800	3·84	0·851	0·867	0·859
1·40	69·10	16,950	4·10	0·935	0·945	0·940

galvanometer used to measure B was one of Crompton's midget type of d'Arsonvals. To eliminate any slight irregularity in the law of the instrument, it was calibrated relatively throughout its scale by successive throws from a standard air coil, the current being measured on a Weston ammeter previously calibrated by a potentiometer. In the double-yoke method the reluctance of the joints can be very accurately determined, and this enables a good estimate of the joint reluctance to be made in one instrument when the standard specimen is put in place. There are then two methods of arriving at the value of H in the specimen when any measured current is passing round the magnetic coil. The first method, which is most accurate at high flux-densities, when a large change in H makes but a small change in B, is to take the total magneto-motive force produced by the magnetising coil, and to

Table II.—Mild Steel.

Current in coil in amperes.	H	B	$\frac{1}{\mu} \times 10^{-3}$	Length of air-gap in inches.		
				Readings with current in each direction.		Mean reading.
0·04	1·97	388	5·08	1·065	1·120	1·093
0·06	2·95	738	4·00	0·766	0·914	0·840
0·08	3·92	1,340	2·93	0·576	0·617	0·597
0·10	4·86	2,235	2·17	0·385	0·425	0·410
0·15	7·17	5,280	1·36	0·245	0·245	0·245
0·20	9·50	7,550	1·26	0·228	0·227	0·228
0·30	14·30	10,550	1·35	0·253	0·246	0·250
0·40	19·30	12,310	1·56	0·300	0·292	0·296
0·60	29·10	14,120	2·03	0·420	0·412	0·416
0·80	39·10	15,020	2·60	0·552	0·548	0·550
1·00	49·10	15,650	3·14	0·692	0·685	0·689
1·20	59·10	16,000	3·70	0·836	0·828	0·832
1·40	69·10	16,350	4·23	0·984	0·981	0·983
1·60	79·10	16,600	4·77	1·136	1·133	1·135
1·80	89·00	16,900	5·27	1·308	1·302	1·305
2·00	99·00	17,100	5·79	1·518	1·504	1·511

deduct the known small magneto-motive force required for the joints, &c., and divide by the effective length o the specimen. The second method, which was relied on at lower flux densities, where the joint-effect might be expected to be most variable in relation to the reluctance of the specimen, is to measure B in the sample by means of a search coil, and deduce the corresponding value of H from the calibration curve of the specimen. The two methods agree well between themselves at those points where they can both be applied. In this way a curve was made connecting the current in the magnetising coil of the instrument, and the value of H applied to the specimen when the instrument is properly balanced. By means of this curve a second scale was marked on the Weston ammeter on which the H can be directly read off. The correction is the same for any instrument made of the same dimensions, and hence has only to be determined once for all for any set. The readings of the screw head were now taken for various values of H, and a curve was plotted with length of air-gap as abscissa and $1/\mu$ as ordinate. This curve is given in fig. 3. It will be seen that this curve begins with a straight line part pointing a little beyond the zero point, which means that with zero air-gap there is still some reluctance due to joints and yoke. As the air-gap is lengthened, the reluctance is at first increased proportionately, but as the gap gets longer still the field spreads more sideways, and a more than proportional increase in length is required to produce the same result in air-gap reluctance. A calculation of the reluctance of the air-gap when quite short gives a value agreeing exactly with the reluctance of the specimen as determined by the double-yoke method.

After this curve had been obtained for Lowmoor iron, a similar test was carried out with rods of mild steel, and it was found that the curve connecting air-gap length and $1/\mu$ (see fig. 3) was the same as that for the Lowmoor iron. Two specimens of hard steel were then similarly dealt with, and the curve was further extended by this means. The calibration of the instrument as a measurer of μ was then drawn in the following way. The first part of fig. 3 was taken as linear, and the reciprocals of the ordinates of this curve were taken as the ordinates of fig. 4; the rest of the curve was plotted by taking the reciprocals of the curve in fig. 3. For many purposes, however, the curve in fig. 3 is itself the more useful.

PHYSICAL SOCIETY.

Ordinary Meeting held May 31st.

Prof. S. P. Thompson, President, in the chair.

A Paper "On the Resistance of Dielectrics and the Effect of an Alternating Electromotive Force on the Insulating Properties of India-rubber," by A. W. Ashton, was read by Prof. Fleming.

The author has obtained from his experiments formulæ for the charging and discharging currents of a condenser with rubber dielectric. The currents are exponential functions of the time. Curves for various potential differences have been plotted and were exhibited. These curves show that the insulating properties of rubber are increased by the application of high alternating electromotive forces.

Prof. Fleming then read a note by Mr. Ashton "On the Electrification of Dielectrics by Mechanical Means."

A sheet of pure Para rubber was placed in a condenser, the plates of which were connected to a quadrant electrometer. A 2-lb. weight was then dropped on to the condenser from a height of 3 in. The electrometer received two impulses of opposite sign, one quickly following the other. The rubber was then stretched while in position, and a potential difference of seven volts was shown between the plates, the top plate being negative. The condenser and electrometer were then discharged, the sheet reversed, and the experiment repeated. The same effect was produced, the top plate again being negative. It appears, therefore, that polarisation of a dielectric being thus produced by mechanical energy, some part of the mechanical energy expended on the india-rubber during manufacture would remain in the dielectric as electric energy.

"A Model which Imitates the Behaviour of Dielectrics," by Prof. Fleming and Mr. Ashton, was exhibited by Prof. Fleming.

The behaviour of dielectrics with regard to their residual charge is analagous to that of wires subjected to mechanical stress. A simple twisted wire is not, however, able to imitate all dielectric effects, and the present paper describes a model which represents things more completely. Six pistons separated by springs are placed inside a vertical cylinder. The bottom piston fits fairly tightly in the cylinder. The second piston fits slacker than the first. The third piston has a small hole in it, and each succeeding piston has a greater area cut away, the top piston having just sufficient metal left to make the spring come to rest without vibration after being compressed. The cylinder is filled with machine oil and vaseline. To the top piston is attached a rod, by means of which pressures can be exerted on the pistons for any length of time. This represents the charging of the condenser. The motion of the rod after releasing the weights represents the discharge of the condenser. This is registered graphically by a revolving drum, and the curves obtained are very similar to those from condensers with dielectrics.

Prof. Ayrton said he would like to know in what respect the model shown was superior to a strained wire. He had noticed about 10 years ago that alternating E.M.Fs. appeared to improve condensers. He was then working with comparatively small voltages, and he was interested to know that Mr. Ashton, working with high voltages, had established the improvement. The deflection obtained by stretching the india-rubber sheet might be due to changes in temperature, the dielectric having a high thermo-electric power.

Mr. Price was glad that the question as to what actually might be called the resistance of a dielectric had been raised. There are two theories of residual charge, one due to Maxwell and the other to Heaviside. The model exhibited represents Maxwell's theory. He considered that the electrometer experiment with the rubber dielectric favoured Heaviside's theory, that is, that the dielectric is composed of small charged bodies similar to the small magnets conceived to constitute a magnet. He expressed his interest in the fact that the top plate of the condenser was always negative.

Mr. Blakesley suggested putting a small hole in the bottom piston of the model so that it might represent a condenser passing a small steady current. With regard to the stretched rubber experiment, he said it would be interesting to make observations with the plates of the condenser vertical.

Mr. Campbell said he had made experiments, and found that the change in capacity of the rubber condenser affects the voltage sufficiently to mask the real effect.

Mr. Appleyard said it was important to have perfect contact between the dielectric and the metal plates.

It was pointed out by a Visitor engaged in the cable industry that manufacturers are aware that pressure affects the insulating properties of gutta-percha. Rubber is a mixture, and different rubbers behave differently under the action of alternating potential differences.

The Chairman said that if the quantity of electricity taken in on charging was equal to the quantity given out on discharge, then there could be no dielectric hysteresis.

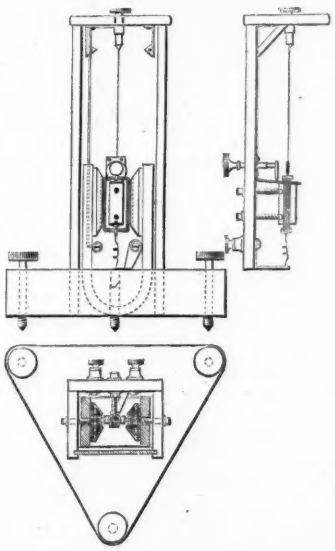
The Society then adjourned until June 14th.

AN INEXPENSIVE MIRROR GALVANOMETER.*

By Prof. A. P. CARMAN.

Within a few years there has been an increased demand for mirror galvanometers which are sensitive, convenient to use, and inexpensive. This demand has come largely from the teaching of physics to elementary students by laboratory methods. The number of classes needing finer apparatus is thus increased, and at the same time the size of these classes has been growing, especially in engineering.

The purpose of this article is to describe the details of construction, the cost, and the performance of a galvanometer which was recently made in the physics workshop of the University for the purpose of finding out how inexpensively an instrument could be made to meet the above demand. The instrument as finally designed and constructed is the result of the suggestions of several persons, but chiefly of Mr. H. V. Carpenter, instructor, and Mr. E. D. Gagnier, mechanician of the department. The aim was to keep all the essential features of the finer instruments, to simplify the construction and to lessen the cost as far as possible.



It is believed that this design puts it within the ability of almost anyone to have a good working mirror galvanometer. Most of it can be made by a person with fair mechanical skill and with the tools ordinarily at hand. The parts requiring a machinist's skill had better be bought, but as will be seen these are few.

The design of the instrument is shown by the accompanying drawing. It is of the d'Arsonval type. This type has many advantages for general laboratory work. It is free from external magnetic disturbances, and hence can be used anywhere; it has a constant sensitiveness, the needle can be brought to rest quickly, and its sensitiveness is high enough for practically all measurement work. The essential parts are the permanent magnetic system and the movable coil. The magnets used were two U-shaped magnets, such as made for telephone magnetos. These magnets can be purchased for 10 cents each. They are strong, and keep their magnetism very satisfactorily. The poles are two pieces of soft Swedish iron, shaped in a milling machine. The magnets are set in a depression cut in the thick cherry base, and the pole-pieces are held in place against them by machine screws, which go through the sides of the case into these pole-pieces. Thus the base and sides of the case are the holders of the magnetic system; the back and top of the case become in a similar way the holder of the movable coil system and the iron core. A piece of plane glass for the front then completes the case. By this arrangement the coil is easily accessible by taking out the two or three screws which fasten the back and top to the sides. The connections are by means of two binding posts on the back of the case. The suspended system has all the ordinary adjustments. It can be raised and lowered and turned around, and it can also be taken off its suspension. The device for lifting it free from its suspension is a flat spring fixed to the iron core, which lifts the coil when the eccentric disc is turned from the back. Turning the eccentric further again depresses the spring and releases the coil. This device is new, as far as we know. It works most satisfactorily, and is not difficult to make.

The coil is wound on a wooden form, and with No. 36 B. & [S. silk-covered copper wire. The resistance in this particular instrument is only 25·6 ohms. Other coils wound with No. 40 B. & S. wire had a resistance of over 300 ohms. A low resistance was desired in this particular instrument.

The cost of the galvanometer may now be given:—

Base and case of cherry	$1.00
Materials—brass, iron, wire, suspension strips, screws, mirrors, &c.	1.25
Machinist's work—two binding posts, three levelling screws, two pole-pieces, iron core, eccentric and spring, suspension head	3.50
Assembling parts and winding coil (if hired)	3.25
	$9.00

The galvanometer, as made, presents a very neat appearance, and it has every convenience, as far as working parts are concerned. Its figure of merit is $2{\cdot}4 \times 10^{-8}$, with the scale at a distance of 1 metre, and with millimetre scale divisions, or about 48 divisions per micro-ampere (10^{-6} amperes).

When we compare this with the d'Arsonval galvanometer from standard makers, we find that it is as sensitive as the ordinary instrument of this type as sold. Thus, taking two instruments of about the same resistance from a list given in the *Philosophical Magazine* for October, 1898, we find a Nalder Bros. instrument of 29·5 ohms giving 3·62 scale divisions per micro-ampere, and a Holden-d'Arsonval galvanometer of 26·7 ohms resistance, giving 0·54 scale division per micro-ampere. It would seem from the above that it should be possible for anyone needing a mirror galvanometer to make one at little cost, and also one capable of the best work.

* The *Technograph*.

THE ELECTRIC WATER-POWER QUESTION IN SWEDEN AND ELSEWHERE.

Last Autumn Prof. S. Arrhenius, the well-known Swedish physicist, was dispatched by his Government to study the utilisation of the waterfalls in various countries with a view to its application in Sweden, particularly as regards the working of railways by electricity, and he has now embodied his opinions in an interesting report, from which we make the following extracts:—*En passant* the Professor points out the industrial lead held by the greatest coal producing countries, that the population is densest where there is coal, as is the case in England, Belgium, France and Germany, and that the non-producing countries are wholly dependent on the former for their industrial existence. This is the case with Sweden, where the coal imports in 1900 amounted to 64,000,000 kr., of which he estimates that the State railways consumed 2,500,000 kr., and the private lines 1,500,000 kr., or 4,000,000 kr. in all, *i.e.*; 6 per cent. of the total. He warns his countrymen, however, against the prevailing idea that the utilisation of the waterfalls would arrest the consumption of coal to any great extent, as this consumption is steadily increasing in spite of all efforts to the contrary, and even a very large utilisation of water-power would not arrest it. As, however, there are no reliable estimates of the powers of the Swedish waterfalls, Prof. Arrhenius has to rely on comparisons between those possessed by France, Italy, Switzerland and Finland. In the three first named countries the total water-power varies between 3,000,000 and 5,000,000 H.P., whilst in Finland, where the conditions are somewhat similar to those in Sweden, the power is estimated at 2,500,000 H.P., exclusive of falls under three metres. He estimates the total power in Sweden at about 4,000,000 H.P., and as the best generating machines consume on an average $\frac{7}{10}$ kilos. per horse-power hour, or six tons a year, this should represent 24,000,000 tons of coal consumed under the most favourable conditions. By way of comparison, the Canton of Geneva, Switzerland, utilises 15,000 H.P. of water, the population being 100,000, so that correspondingly Sweden, with 5,000,000 inhabitants, in order to develop a similar industry, should require 750,000 H.P., or only one-sixth of its total resources—*i.e.*, far less than the supply. This shows that the water-power in Sweden is very plentiful, and that only the best falls will be utilised for many a day. Unfortunately, their utilisation is very costly, and as most industrial works are located near the sea far away from the falls, it will be very long before they can be brought together, and the power turned to full account. Therefore the value of the Swedish falls is greatly exaggerated at

the present day; yet the time may come when their value will be fully realised.

The turbine installation at a waterfall is cheaper in proportion with a big than a small fall, and less per horse-power when the fall is higher.

It is generally reckoned that the horse-power is ten times the product of the number of cubic metres which fall in a second, multiplied by the height of the fall in metres. The cheapest of all the installations visited by the Professor are those in the French Alps (Savoy), where the average price is 100 fr. per horse-power at the turbine axle — *i.e.*, without transmission. However, the *normal* cost is twice as high, or some 300 fr. per horse-power; but as a warning to water-power enthusiasts, he mentions that the cost in some places rises to 1,000 fr. and 1,200 fr. per horse-power at the turbine axle. But the average cost per horse-power year at the foreign waterfalls, inclusive of acquisition, &c., with a fall of 3 metres is 600 kr.; with one of 5 metres, 500 kr.; 10 metres, 400 kr.; 30 metres, 300 kr.; and 70 metres, 250 kr.

In Sweden, on the other hand, the conditions being more favourable, the costs in four similar cases would vary from 180 to 200 kr. However, these figures represent only the actual cost of the water installation, but the cost of the transformation and transmission to distant parts is much greater, and there is an additional cost where the current has to be distributed in towns. The former cost ranges from 0·08 to 0·95 öre per horse-power hour. Nevertheless, an advantage of the electrical stations is that they require so little labour, and are independent of the variable question of wages, but a drawback is that the cost is the same whether the power is utilised all day and night, or only a portion of the time. Thus, for electric lighting required only for half a dozen hours, the cost of water-power is many times greater than for a 24-hour supply.

On comparing the cost per horse-power with steam, Prof. Arrhenius maintains that the latter is a dangerous competitor with electricity in working big machinery, and that steam cannot be replaced by water power when the latter has to be transmitted long distances.

As regards the much-vaunted application of water-power for the working of railways, there were great difficulties, and it could not be used on the present systems. Working by electricity necessitated the cutting up of long trains into short ones, and running them continuously, but the electrical system will be a capital one for the traffic on mining railways, which run continuously to and fro with ore and goods. Moreover, with the present methods, the force cannot be transmitted more than 150 kiloms., so that a line thus worked cannot exceed 300 kiloms. in length, and when there is no continuous service, the use of water-power would be very difficult. But as regards speed, electricity takes the palm, as will for instance be presently demonstrated on the express electric line between Berlin and Hamburg, where the speed is to be 200 kiloms. an hour. However, in Sweden the utilisation of electricity instead of steam for the working of railways, is a secondary matter compared with the question of using water-power for industrial purposes.

Finally the Professor deals with the different electrical systems for railway traffic. The simplest of these, he says, is that used on tramways, but this cannot be applied on longer distances, as the direct current thus applied has a low pressure, and cannot be applied on long distances without great loss. The Thury system, with the aid of auxiliary apparatus, of generating a high voltage has certainly succeeded to some extent, but cannot be said to have solved the problem satisfactorily. In order to create a high voltage, an alternate current is preferable, which may be transformed to a higher or lower voltage, whereby a favourable transmission of force may take place. The most suitable for this purpose is the three-phase system, where the force is transmitted over the ground through three conductors, against which run three shoes from the motor car. With this system no transformer on the line is required, only one on the train. The best of these systems, the Professor maintains, is that of Messrs. Siemens & Halske, which is now to be largely applied on the German railways, and in which the Kaiser is greatly interested. He considers that this system is preferable to others mostly adopted in the United States.

REVIEWS.

Electric Light Cables and the Distribution of Electricity. By STUART A. RUSSELL. Second Edition. Whittaker and Co.

The first edition of this book appeared ten years ago. The interim has been marked by radical changes in methods, and developments in principles; the task of revision to cover a period so long and so progressive is therefore no easy one. Cables, distribution systems, units, culverts, prices, Parliamentary powers, everything, in fact, with which this book concerns itself, has in this decade undergone change; it is necessarily difficult in such small compass to trace the history and to report upon the results attained during that period. In the present edition an attempt is made to modernise the original, and the attempt generally is successful; there are certain paragraphs of it, however, that we should have preferred to see rewritten rather than revised.

Of parts that have received new treatment we note especially Chapter III., which deals with the problem of economical design and economical conditions of working feeders and sets of feeders. The law enunciated in 1881 by Lord Kelvin, that the most economical size of conductor is that for which the annual cost of wasted energy is equal to the annual charge for interest and depreciation on that part of the capital outlay which is proportional to the area of the conductor, is shown to require very careful application. The author indicates the limitations of that law, and discusses the question of apportioning the various items of outlay to their proper schedules. He indicates which should be considered as those whose cost varies with the waste energy in the conductors, and in a separate category he collects items whose costs are practically independent of the conductor losses. It is shown that the load factor and the cost of fuel introduce complications, and that every undertaking must be worked out item by item according to its own conditions, afterwards collecting terms. In this way Lord Kelvin's law, which it has become the fashion to regard as of academical interest merely, proves itself to be capable of modification so as to yield results of undoubted practical value. And similarly, it may be applied to the converse case, in which the problem is to determine the most economical current for a conductor which is already laid.

In Chapter XV. Mr. Russell discusses with great force and clearness the advantages and disadvantages of earthing one or more points in a system of cables, and he considers how such earth connections affect the working and maintenance of a system, both for separate cables and concentrics. The earthing of the middle wire permanently throughout its length, as a means for preventing interference with telephone circuits, is criticised unfavourably to the decision of the Verband Deutscher Elektrotechniker. It is shown that interference with telephony may take place either with an earthed or with an insulated middle wire, and that there is insufficient advantage to be gained by so earthing the middle wire, as against the disadvantages as regards localising faults. The earthing of the middle wire at the station only, so that the earth connection can be broken when testing for faults, is to be accepted as the best method, especially if the earth connection is made through a low-resistance ammeter to indicate at all times the condition of the mains.

Taking a practical view of temperature correction for copper resistance, Mr. Russell is, no doubt, right in adopting the straight-line law in preference to the logarithmic as the best for every-day calculations for electric light cables. If simplicity of calculation is alone considered, there is, in our opinion, nothing to choose between them. The straight-line law is easier for the slide rule, and the logarithmic law is easier for log-book arithmetic. Such differences as may arise in practice from applying one law or the other are of the same order as the variations in the coefficients themselves, between various specimens of copper. This being the case, we confess to a leaning towards the logarithmic law, and we cannot go so far as Mr. Russell, who considers that the straight-line law is equally accurate. Assuming that the respective coefficients are determined with equal precision, the limits of accuracy for long ranges of temperature, should be in favour of the logarithmic law.

In the earlier chapters there appears to be a little need for explanation in the matter of units. Thus the resistance at 32° F. of a soft annealed wire of pure copper, 1 ft. long and 0·001 in. diameter, is given as 9·583 ohms, and tables of figures are worked out, apparently on this basis, with nothing to indicate what ohm is meant. Similarly, the temperature correction for copper is given in the text as $R_t = R_{32}\{1 + 0{\cdot}00222\ (t - 32)\}$, but in the appendix the coefficient is stated as 0·00238, which is practically that found by Clark, Forde and Taylor in 1889—a coefficient far more accurate than the 0·00222 of the text.

Chapter XVI., which gives an account of the various systems of mains in use, is now fairly representative of modern practice, though it leaves a number of points of detail untouched. Here, as in the whole of the book, the value of the remarks would be greatly enhanced if references were added, stating the sources from which the data are derived. Chapter XVII. discusses methods of testing the

insulation of circuits without interrupting the supply, and various methods of localising faults. This is a subject upon which Mr. Russell has many useful remarks to make. He advocates a complete system of testing cables, beginning at the factory, continuing during the operations of laying, and repeated at frequent definite intervals when they are *in situ*.

It is remarkable that a book published in 1901 describing tests of the insulation resistance of cables should contain no mention of Price's guard-wire. Mr. Russell explains how the "ends" are to be pared down, cleaned and lamped, and even suggests painting them with hot paraffin wax—in practice, quite a superfluous operation—but he omits to say that all this trouble can be avoided by the simpler and more effective proceeding of adding a guard-wire.

Of other parts of the book that seem to require revision, we notice that on p. 107 the Britannia joint is described with ends bent up. This custom, we believe, has long been discarded, if not actually condemned, by the Post Office, as it was found that the operation of making these bends stretched the binding wires, thus leaving a space at the ends of the joint, into which the solder will not run. The design of posts and insulators for overhead wires is also a matter which might with advantage be dealt with on more modern principles. That the book has been too hurriedly, and yet withal too tardily, revised is apparent. But the defects and omissions, such as they are, occur almost entirely in matters of detail—a necessary consequence of the long interval between the editions. Mr. Russell thinks cautiously and writes clearly, and the reader who follows his arguments will admit the soundness of his judgment. We venture to hope that a third edition will shortly appear in which these smaller matters are corrected.

Journal of the Institution of Electrical Engineers. No. 149. London: E. & F. N. Spon, Limited. 1901.

This number of the *Journal* contains papers on the Use of Aluminium as an Electrical Conductor, by J. B. C. Kershaw; Capacity in Alternate Current Working, by W. M. Mordey; the Electrical Power Bills, 1900, by W. L. Madgen; Dublin Corporation Electric Light Scheme (Abstract), by R. Hammond; Electrically-Driven Machine Tools, by G. Ralph; a Method of Compensating Voltmeters for Voltage-Drop in Long Feeders, by M. B. Field; and an original note on Resonance with Alternating Currents, by A. Russell. Some of the papers were followed by exceedingly interesting discussions.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS, 1901.

Compiled expressly for this journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, Manchester, and Birmingham, to whom all inquiries should be addressed.

10,903. "Improvements relating to the electrolysis of salt." E. J. Plummer. May 28th.

10,933. "Improvements in joint and like boxes for electric cables." A. E. Tanner and W. P. J. Fawcus. May 28th. (Complete.)

10,935. "Improvements in domestic telephone plants for physicians and others." A. Traut. May 28th. (Complete.)

10,951. "Battery elements support." C. B. Schoenmehl. (Date applied for under Patents, &c., Act, 1883, Section 103, October 30th, 1900, being date of application in United States.) May 28th. (Complete.)

10,960. "Circuit closing device for the winding gear of electric clocks and the like." M. Moeller. May 28th. (Complete.)

10,961. "Electric striking clock." M. Moeller May 28th. (Complete)

10,967. "Improvements in stationary armatures and inductors." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) May 28th. (Complete.)

10,971. "Improvements in and relating to controllers for electric railway and like vehicles." H. H. Lake. (W. W. Tice, United States.) May 28th.

10,974. "Improvements in and connected with electrodes for electrolytic cells." P. M. Justice. (Castner Electrolytic Alkali Company, United States.) May 28th. (Complete.)

10,975. "Improvements in electrodes for electrolytic cells." P. M. Justice. (Castner Electrolytic Alkali Company, United States.) May 28th. (Complete.)

10,976. "Improvements in electrolytic cells." P. M. Justice. (Castner Electrolytic Alkali Company, United States.) May 28th. (Complete.)

10,988. "Improvements in telephone circuit systems." E. F. Frost. May 28th. (Complete.)

11,000. "Improved electric heating device." E. Kastner. May 28th.

11,003. "Improvements relating to apparatus for transmitting and receiving electric signals." G. F. R. Blochmann and C. E. Bichel. May 28th.

11,007. "An improved combined electrical and mechanical motor." A. Benson and J. P. Price. May 28th. (Complete.)

11,013. "Improvement in circuit closing and interrupting devices." F. Kuhlo. May 28th.

11,034. "Improvements in starting switches for electric motors." T. E. Weaver. May 29th.

11,050. "Electric arc lamp." E. M. Barnes. May 29th.

11,071. "Improvements in electrical connections." J. Gray. May 29th.

11,076. "Improvements in and relating to means for extinguishing electric arcs applicable to lightning arresters, switches, and the like." H. Lamm. May 29th. (Complete.)

11,112. "Improvements in trolleys and junction frog plates for use on electric railways and tramways." D. B. Foster. May 30th.

11,120. "Improvements in galleries or holders for gas, electric light, oil-lamp and the like globes or shades." B. F. Wyler. May 30th.

11,134. "Improvements in rail bonds for electric railways." C. B. Thwing and C. G. Wiborg. (Date applied for under Patents, &c., Act, 1883, Sec. 103, November 10th, 1900, being date of application in United States.) May 30th.

11,135. "Improvements in or relating to electric arc lamps." S. H. Johnson. May 30th.

11,168. "Improvements in vehicles driven by electricity." V. I. Feeny. (Allgemeine Elektricitäts Gesellschaft, Germany.) May 30th. (Complete.)

11,172. "Improvements in electricity meters." M. Kallmann. May 30th.

11,214. "Improvements in wireless telegraphy." H. Shoemaker. (Date applied for under Patents, &c., Act, 1883, Section 103, January 17th, 1901, being date of application in United States.) May 31st. (Complete.)

11,237. "Improvements in or relating to electric arc lamps." Societa Generale Italiana Edison di Elettricita. (Date applied for under Patents, &c., Act, 1883, Section 103, November 26th, 1900, being date of application in Italy.) May 31st.

11,242. "Improvements in electrical primers." Sir W. G. Armstrong, Whitworth & Co., Limited, and G. Stuart. May 31st.

11,253. "Improvements in or connected with the application of electric motors to the driving of machine tools." The British Electric Plant Company, Limited, and W. L. Spence. June 1st.

11,254. "Improvements in incandescent light fittings, more particularly applicable to electric incandescent lights." C. M. Stead. June 1st.

11,257. "Improvements in and relating to electrolytic incandescence lamps." J. R. Quain and T. T. Turnbull. June 1st.

11,277. "An improved apparatus for utilising electric lamps in the heating of plates and other domestic utensils, and in the boiling of water and other liquids." R. W. Boyd, June 1st. (Complete.)

11,280. "Improvements in electrical reversing switches, and in mechanism for operating them." C. de Kando. June 1st. (Complete.)

11,290. "Improvements in electric contact makers and breakers." The Pick Motor Company, Limited, and J. H. Pick. June 1st.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, Manchester and Birmingham, price, post free, 9d. (in stamps).

1899.

16,308. "An improved operating device for electric bells and house telegraph signals." F. Schuchhardt. Dated August 10th, 1899. An electro-magnetic generator is used to replace the battery and push of electric bells and house telegraph signals. The generator comprises a magnet supported by plates and an armature contained between its recessed poles and actuated through a train of wheels by a rotary knob. The apparatus is enclosed in a casing. 1 claim.

16,311. "Improvements in, or connected with, dry core electrical cables." H. Lavage and W. T. Henley's Telegraph Works Company, Limited. Dated August 10th, 1899. Dry core cables are built up containing a central or other strand covered with rubber or other non-hydroscopic material to facilitate testing, &c. 1 claim.

16,373. "Improvements in vibrating switches or contact breakers for induction coils, bells, and the like." J. Burns. Dated August 11th, 1899. Switches for induction coils, bells, &c. The spring forming the vibrator or trembler is fixed at both ends, the armature being fixed in the middle. The spring may carry a contact-stud, or be fitted with a small supplementary spring carrying a contact-stud. 3 claims.

16,382. "Improvements in connection with spindles, and the driving of the same by electricity." J. G. Lorrain, M.I.E.E., and M.I.Mech.E. (H. B. Sawyer). Dated August 11th, 1899. Relates to electrically-operated spinning-machines. Each of the spindles is driven by an alternating current motor of the induction type, so arranged that the spindle will remain properly balanced when running at a high speed, and will also have its speed automatically regulated according to the diameter of the bobbin and the strength of the thread with relation to the strain upon it. The several spindle motors, as well as the main motor which drives the feed-roller, are provided with brakes which may be simultaneously operated by the same means as the controlling switch. The spindle carrying the bobbin rests upon a step bearing, and runs in a tubular bearing which is yieldingly connected to the step bearing and automatically adjustable with relation thereto. Upon the lower part of the spindle is mounted the rotor of an induction motor, the said rotor consisting of a laminated iron cylinder carrying conductors forming a closed circuit. Surrounding this is the stator, consisting of a laminated ring provided with inwardly projecting pole-pieces and wound with four coils or sets of coils, arranged so as to produce a rotating magnetic field when supplied with two-phase alternating currents. The air-gap between the rotor and stator increases slightly in width from below upwards, so as to allow of the proper gyratory movement of the spindle. To protect the motors from dust, &c., and prevent withdrawal of the spindles and rotors when removing the bobbins, they are enclosed by hinged guard-plates. The spindle brakes and the main motor brake are operated simultaneously from the shaft of the controlling switch. The spindle brakes consist of a number of fingers carried by a rock shaft, whereby in stopping the machine each of the rotors is lifted until it strikes a stop on the stator or frame. The requisite movement is given to the rock shaft by a weighted lever supported by a chain from the shaft which carries the switch contacts. The main motor shaft carries a disc to which brake-blocks carried by a weighted lever are applied in a similar manner. 27 claims.

16,395. "A new or improved arrangement for controlling electric elevators." E. A. Wahlstrom. Dated August 11th, 1899. The cage is suspended from a drum driven by spur gearing from the armature shaft of the driving motor. A counter-shaft is driven by pulleys from the cage shaft. This shaft has fixed to it a disc carrying contact strips. Opposite to it on a shaft operated by a hand-pulley is a contact arm in communication with the lead. When, therefore, the arm is rotated to bring it in contact with either of the plates, a circuit is completed in one or other direction through the field magnets of an auxiliary motor. This specification is too complicated for purposes of abridgment. 14 claims.

16,410. "Improvements in electric arc lamps." A. Eckstein and A. E. Angold. Dated August 12th, 1899. Arc lamps.—A short clutch lamp is constructed. The frame consists of a suspender and cover, a central tube, and a baseplate carrying a casing. An arc-enclosing globe is held against a cap on the central tube by the lower carbon holder, below which a holding screw is carried by flat springs on rods hinged to the baseplate, so that the parts can be swung aside.

The upper carbon slides in the cap, and its upper end is clipped in a socket provided with contact springs, sliding in the central tube. The socket consists of two half-tubes carried loosely on a pin in an outer tube, and having their upper ends pressed apart by springs so that their lower ends clip the carbon. The socket is accessible through slots in the central tube. The carbon is passed through a clutch carried at its ends by two vertically-movable rods, which pass through small openings in the baseplate. One rod is connected by a surrounding spring with the baseplate, while the other is connected by a regulating lever with the movable cores of the series and shunt solenoids and a dashpot. The baseplate carries a series resistance. 4 claims.

16,439. "Improvements in or relating to arc lamps." G. C. Dymond, M.I.M.E. (C. J. Herring.) Dated August 12th, 1899. A clutch lamp with enclosed arc is constructed in the following manner:—The frame consists of a top-plate and annular yoke carrying an insulated three-legged casting, a dashpot, a tube, a cap, a plate, and an insulated holder for the lower carbon. The casting supports, but is insulated from, two plates held apart by lugs. The upper carbon is placed in a socket sliding in an inner tube, which is movable vertically in a guide ring in the cap, and is provided at the upper end with a guiding flange and dashpot piston. The socket may be fixed by a pin during the insertion of a new carbon; the inner tube carries an ordinary clutch upon the plate and is suspended by a chain passed over a pulley to a bar connecting the cores of two series solenoids carried on the plate. These solenoids may be wound on grooved porcelain bobbins with wire of high resistance, to reduce the separate series resistance, which is wound on a grooved cylinder held between the cap and plate, and is provided with a movable connecting band. The arc-enclosing cylinder is made with a bead to engage a ring which is screwed on the cap. An outer globe is attached to a perforated cylindrical case carried by the plate. The upper part of the lamp is covered by casings attached to the top-plate. 19 claims.

16,444. "A method of receiving telegraph signals as displayed or photographed by magnetically deflected cathode rays." Siemens, Bros. & Co. (Siemens & Halske Aktien Gesellschaft.) Dated May 12th, 1899. Relates to telegraphic receiving apparatus for Morse, automatic, or other systems of transmission. The principle employed consists in deflecting cathode rays by means of one or more magnets in the line circuits and allowing the rays to fall on a fluorescent screen, from which they are projected in the form of light rays on to a photographic strip. The currents employed may vary simply in duration, for dot and dash, may vary in strength owing to interpolated resistances at the transmitting station, or several magnets may be employed, in the two latter cases the rays being caused to project letters or shadows of letters on to the strip. The simplest form consists of an automatic dot and dash transmitter, a line magnet acting on the cathode rays, a fluorescent screen and a lens for bringing the rays to a focus on the strip. The strip is screened except at one point. One or more mirrors or total-reflecting prisms may also be employed. 3 claim.

16,494. "Improvements in or relating to automatic cut-off devices, principally designed for controlling the flow of fluids and of electric currents." H. L. Groome. Dated August 15th, 1899. Relates to apparatus for controlling the flow of fluids such as gas or steam, &c., in factories, or the passage of electric currents for lighting, or for exploding mines, &c. The invention is too complicated for purposes of abridgment.

16,669. "Improvements in accumulator electrodes." Dr. R. A. Katz. Dated August 15th, 1899. Electrodes for lead accumulators, especially suitable for traction purposes, are constructed in the following manner:—An open-work frame of caoutchouc, celluloid or other acid-proof and non-conducting material receives the active material in the large spaces separated by the grating bars. Thin perforated lead plates, which may be renewed from time to time, are pressed against both sides of the frame, so as to be in close contact with the active material. The electrodes so constituted are separated by celluloid, &c., frames formed with two staggered gratings, each half the thickness of the frame, so that free circulation of the electrolyte is possible. Openings are made at the top and bottom of the frames to facilitate the escape of gas, &c. The electrodes and separators are pressed firmly together by wedge pieces. In a modified form of construction, a celluloid grid is divided by a perforated vertical partition into two portions, of which one-half is filled with active material, and the other half is left empty. One such grid is placed on each side of the thin lead plates, so that the active material is in contact therewith on both sides. The empty portions of the grid serve as separators, and receive the electrolyte. 5 claims.

16,600. "Improvements in the manufacture of earthenware troughs for carrying electric cables, and analogous purposes." G. H. Nisbett. Dated August 16th, 1899. Conduits for electric conductors and other similar purposes, of the kind described in Specification No. 462, A.D. 1898, are formed in lengths preferably of oval section, and have sockets and spigots on the ends. Nicks or grooves are formed longitudinally at the ends of the smaller axis, to facilitate dividing after manufacture and before use. The nicks may be either internal or external. The sockets or spigots may be flattened to give resting surfaces. The cables, &c., inserted in the conduits may be set in bitumen. The conduits may be formed in the form of troughs or half tubes, instead of in tubes which are afterwards divided. 3 claims.

16,628. "Improvements in arc lamps." J. D. F. Andrews. Dated August 16th, 1899. Arc lamps: A cylindrical casing carries supports for the lower carbon, and contains an inner cylinder on which is a ring holding a terminal insulator. The solenoid, uniformly wound, without a bobbin, fits between coned insulating discs placed in the cylinder. The upper disc supports the rounded head of a central metal or other tube, which is otherwise free. For use with alternating currents, the tube may be divided longitudinally, and provided with insulating layers. The head is held down by a spring attached to one terminal, and an intermediate insulating disc provided with metal bearing surfaces, the upper of which is connected electrically to one end of the solenoid winding. The upper carbon is inserted in a holder on a piston of steatite, or consisting of two metal discs, an asbestos covering, and an asbestos cup packing working in the outer cylinder. The solenoid core on the piston carries a spring of N form in plan, to make connection with the tube supported by the upper disc. The upper carbon holder, and a weight or a lighter lower holder, are carried by a cord and pulley or spring drum. A brake strap of velvet is attached at its ends to a spring and brake lever, the outer end of which is carried by a spring and a core in a solenoid, while it may rest at its centre on a fixed stop. 6 claims.

16,636. "Improvements in electrical accumulator batteries." E. Placet. Dated August 16th, 1899. In order to increase the portability of plates or electrodes they are constructed of a light support which is coated on both sides with a thick layer of a paste formed of a mixture of glycerine with one or more oxides of lead to which may be added either powdered inert material such as starch or magnesia, which will subsequently be dissolved out, or materials such as camphor, or naphthalene, which will afterwards volatilise. The light support may be a sheet of ebonite, celluloid, gutta-percha, linoleum, wood, paper, asbestos, earthenware, or carbon perforated and, if necessary, channelled and having wire or other metal strips wound around it. The light support may also consist of felt, cloth, horse-hair, canvas, or other tissue saturated throughout with paraffin, bitumen, caoutchouc, silicate, marine glue, or other substance that will protect the material from decay and from the attack of the electrolyte. The light support may also be made of wire gauze folded on itself, and in this case the active material is pasted not only on the outer surfaces, but is also filled into the spaces between the folds. 5 claims.

16,550. "Improvements in conduits suitable for electric mains." T. Petersen. Dated August 16th, 1899. Conduits for electric mains which, after laying, are filled with bitumen are formed elliptical, with grooves at the ends of the minor axis. The elliptical conduit is divided along these grooves to form two equal trough conduits. 2 claims.

16,739. "Improved road contact and like systems for electric railways." W. Grunow, jun. Dated August 17th, 1899. Relates to electric railways and tramways on a road contact or like system with electro-magnetic switches. Conductors, switches: Current is supplied to the vehicle from sectional rails which are connected to the main conductor through the cover of the switch box, movable magnet which completes the circuit and flexible connection. The magnet is lifted when excited by a shunt current from the second series of sectional rails through its coil and resistance to the return rail. Various modifications are described, in which one or both sets of the sectional rails are replaced by short lengths or studs, or a single series answers the purposes of both sets. The conductor from the main may also be coiled on the magnet for holding it up while the vehicle is on the section. A battery current from the vehicle may replace the shunt current. A form of the switch with a double coil is described as follows: It is contained in a box of insulating material with lugs for attachment and a metallic water-tight cover bonded to the sectional rail. The flexible connection, which allows the magnet to ride over a central guide into contact with the cover, is clamped to the feeder and is connected through the thick coil to the core of magnet. The head of the cores may be a carbon plate or spring copper, &c., plate. 30 claims.

16,820. "Electrically-controlled design-reading apparatus for punching Jacquard and like cards." B. J. B. Mills. (L. David and T. David.) Dated August 18th, 1899. An electrically-controlled design-reading apparatus for punching Jacquard and like cards, comprises a card on which the design is presented on a metallic sheet divided into zones insulated from each other and representing the colours or mountings of like nature. The card is mounted upon a carriage and traversed beneath a comb, the teeth of which are insulated from each other and are connected by conductors to a series of electro-magnets. The circuit is completed by a conductor, battery, and commutator, which by means of contacts sends the current at will through any one of the zones. The electro-magnets act upon light pendulums, and attract them to such an extent that they are not lifted by a griffe, which is periodically operated by a cam. The other pendulums lift the corresponding needle into position to be acted upon by another griffe which pushes the corresponding needles of the punch-selecting Jacquard out of action with a third griffe. The Jacquard needles corresponding to the attracted pendulums are lifted by the third griffe and make the required selection. 2 claims.

16,824. "Improvements in apparatus for electro-chemical and electrothermic melting operations, especially for the production of calcium carbide." E. Grauer. Dated August 18th, 1899. An arc furnace for making calcium carbide, or for other melting operations, consists of a vertical hollow electrode through which the materials are supplied, above a crucible forming the other electrode, in closed casing, one electrode being moved circularly relatively to the other by a crank to spread the materials uniformly. The crucible is stationary. The hollow electrode passes through a disc closing the top of the casing, and is connected by a fork with a supply hopper, a pin, and the crank on a rotating shaft. Electric connection is made with the pin by a spring clip, an arm of which engages a slotted stop. Otherwise the hollow electrode may be fixed in the top of the casing, and the crucible movable circularly by a crank situated below it, and operating similarly to that illustrated, except that the connecting clamp is arranged to prevent rotation of the crucible on its own axis. 2 claims.

16,854. "Improvements in connection fittings for various electrical purposes." R. F. Hall. Dated August 19th, 1899. Relates to binding posts or terminals for fittings, such as tumbler, &c., switches, cut-outs, measuring instruments, &c. In one form the terminal block has a screwed shank for attachment to the fitting. Through it is a perforation for the passage of the conductor, which is clamped by the eccentric or can-shaped head of a rotary pin. The terminal may have a recess for assisting the gripping action. In a modification the eccentric head does not directly grip the conductor, but operates a slide. 3 claims.

16,878. "Telephonic apparatus for transmitting and receiving messages simultaneously to and from several distant stations." Siemens Bros. & Co., Limited. (Siemens & Halske Aktien Gesellschaft.) Dated August 19th, 1899. Relates to telephonic systems in which, by using a common diaphragm to several microphones, a message can be sent simultaneously to a corresponding number of stations distant. Similarly, the receiver circuits of the distant stations are brought to a number of receivers having a common sound diaphragm or ear-piece. 1 claim.

16,879. "Method for dividing an alternating current into two currents, whose phases are shifted relatively to each other through a determined angle" Siemens Bros. & Co., Limited. (Siemens & Halske Aktien Gesellschaft.) Dated August 19th, 1899. Relates to the method and apparatus described in Specification No. 2,559, A.D. 1897, for dividing an alternating current into two currents having relatively shifted phases. The connections may be arranged like a Wheatstone bridge; inductive resistances and condensers are arranged in opposite branches, and produce a rotary field in a motor. In another arrangement only one condenser is employed, this being inserted in the secondary circuit of a transformer. A diagram is included in the drawings showing geometrically the relative current strength and phase shift. 2 claims.

7,470. "Improvements in, and apparatus for, effecting electrolysis." W. L. Wise (Solvay & Co.) Dated March 28th, 1898. Relates to the electrolysis of alkaline chlorides and other salts by the use of a mercury cathode. The tank is provided with a layer of mercury which continuously overflows at the adjustable weir, carrying with it the amalgam formed, and thereby always presenting a clean surface. It then passes to another, which may be a similar electrolytic apparatus, in which the mercury is regenerated. The mercury is raised by an elevator or pump, and enters the well at the opposite end to the weir. This circulation is continuous. When it is desired to clean out the cell, one end may be raised by a screw. The electrolyte is preferably caused to continuously flow in the same direction as the top mercury layer. 4 claims.

7,569. "Improvements in electric furnaces." H. H. Lake. ("Volta" Soc. Anonyme Suisse de l'Industrie Electro-Chemique.) Dated March 29th, 1898. In a furnace applicable for making calcium carbide, a casing is filled with small coal, and supports carbon blocks and plates, enclosing powdered carbon and forming an electrode which becomes incandescent. An upper casing supported on insulating bricks, surrounds adjustable electrodes placed one over each block, one being near the outlet for the fused product. The materials are supplied between the electrodes. The gases produced pass through the materials, stirring them and depositing volatilised products. It is stated that such a furnace may be constructed to use 9,000 KW. 5 claims.

15,967. "Improvements in electric arc projecting lanterns." L. Kamm. Dated August 4th, 1899. The lamp is mounted on a platform adjustable longitudinally on rods sliding through blocks. The frame of the lamp is in two parts pivoted for angular adjustment in a vertical plane, while for transverse horizontal adjustment one part can be turned on a pivot by means of set screws acting on lugs on either side of the pivot axis. The rods carrying the carbons are telescopic and can be clamped as required by set screws; spring clips hold the carbons which, when adjusted, can be fixed by set screws. Two parallel sets of resistances arranged in series are provided for the lamp, the required number in the upper series being brought into the lamp circuit, through a rod and terminal by a sliding switch coming in contact with insulated plates. 5 claims.

11,646. "Improvements in devices for securing incandescent electric lamps in their sockets." W. Ravene. Dated June 5th. A lamp bulb is made with two depressions to receive the ends of supporting fingers which are pivoted on a base and are operated by an interposed spring. Two pins slide on the base and each other and have projections engaging the fingers to free the lamp when they are pressed inward. The leading-in wires of the lamp terminate in knobs on the surface of the glass. Contact with these is maintained by two metal pieces fixed on an ebonite plate, which is supported on two vertical guide screws by springs. The guide screws pass down to plates to which the supply wires are connected. 2 claims.

18,254. "Improved construction of electric accumulator plates." E. F. A. Polzin. Dated September 9th, 1899. Relates to plates or grids for holding the active material in place. The grid is in two parts, both of which are slotted so as to leave openings which are narrower on the outside of the plate than on the interior. One of the plates has a flange or rim and a number of projecting parts with recessed ends, on which, after the active material has been inserted, is placed a similar plate, but without a rim and projections, and having holes in which the recessed ends of the projecting parts fit, and the two are pressed together by pressure between the two flat plates. 2 claims.

18,390. "Improvements in ventilating fans of that class which is employed in connection with electric motors." P. M. Justice. (Emerson Electric Manufacturing Company). Dated September 12th, 1899. The fans are of the type used with electric motors, and the improvements are designed to prevent noise. The blades are secured to lugs on the boss, and have a certain pitch; the forward edge of the blade is curved, and the adjacent portion of the driving surface is flattened into the plane of rotation. Fins on the rear edge are bent so as to direct the current of air into the form of a solid instead of a hollow cylinder. 4 claims.